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'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

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METEOROLOGICAL CONDITIONS.

THESE are influenced by various agencies—*the aspect, the elevation*, the conditions which may arise from the place being *among hills, on a plain* or *in a valley*. All these points have to be considered, also the distance from the *sea-coast*, the influence of *sea-breezes* and surrounding objects, such as *mountains* or *inland lakes*, a long *sea-board*, or a *marshy neighbourhood*. The *prevailing winds*, the prevalence of *clouds*, the quantity and intensity of the *rainfall*, and the general character of the air as to moisture, and the presence of *ozone*, continuous or otherwise in its composition. All these points go to make up what may be called the climate of the place or country. Many people think that the climate is not dependent upon conditions which can be altered by man, and that the healthiness or unhealthiness of a given place arises from circumstances beyond man's control. Such a conclusion is erroneous, for the human frame is so constituted that it can become acclimatised, so as to bear great alterations of temperature and moisture without serious results necessarily following, when the sanitary state of the place is in accordance with good hygienic laws. History tells us some decided facts bearing upon this point. There are places in both the East and the West Indies which were always fatal, sooner or later, to the European constitution a hundred years ago; but which are now as healthy for our troops and colonists as many of the home stations. This change has been effected by attention to the laws of hygiene. There are points which cannot be altered, and which produce results hurtful, or the contrary, according as to whether the good side has been taken advantage of, or the bad side of the position guarded against. We will consider more in detail the points which I have just set out.

The Aspect.—If we are fixing upon a site for a new dwelling it will be comparatively easy to avoid some of the evils which must be submitted to and have to be guarded against in towns already peopled, which are much influenced in their effect upon the health by weather, etc. The plan for a new house or town should be so arranged that those rooms which are intended for occupation as living rooms should get the direct rays of the sun as long as possible. Those parts which cannot be so illuminated should be occupied by the offices of the dwelling. The northern aspect may be so utilised. Windows on the north side are, however, useful for indirect sunlight and for ventilation, and are not to be omitted when necessary for such purposes. Stack-pipes, ventilating pipes, and annexes for w.c.'s may be placed on this aspect. There should be shelter from the north and east winds when the situation is an exposed one. This may be secured by belts of trees, or by placing the house so that a rising ground intervenes and shelters it from the wind. There is sometimes a great inconvenience from this situation, the wind when sweeping over the hill is apt to come down again with renewed force, and to make the chimneys smoke in spite of all the contrivances which are used to disfigure the house-top as smoke preventives. The best remedy for the evil is to raise the chimneys high enough to escape the down-blast. The sun should illuminate both sides of a street. One running directly east and west must necessarily have one side of its row of houses always shut out from the direct rays of the sun. Such a street is not so satisfactory as one planned from north to south. The width of the street should always exceed the height of the houses which are to be built in it. Right angles in streets are to be avoided unless there is a break in the building so as to allow ventilation at the angle. In placing a house it is necessary therefore to get as much sunlight and fresh air as can possibly be obtained.

The elevation of the site is important for several reasons, especially those connected with the natural drainage of the district. Houses may be built a little above the line of high water on the sea-shore, or on a tidal river, if the ground is not land-locked close to them, but such a position is unhealthy if there is not free ventilation. I have noticed how anæmic and delicate-looking those people become who live in such houses, whilst those on promontories which are well set out in the open are ruddy-faced, healthy-looking people, though, perhaps, only separated by a jutting headland from their anæmic neighbours. The side of a hill which is swept by the wind will be healthier

BRITISH MUSEUM

than a site in a nook surrounded by high land on three sides of it. An open plain, all things being equal, is far preferable to a land-locked valley; the cold is more intense in such valleys than at higher situations close by. I have repeatedly seen, in the coombes of the Surrey Hills, the vegetation at the bottom of the valley destroyed by the frosts of early spring, when more delicate plants, growing a hundred feet higher on the hillside, have not been touched by the cold. Some kinds of illness, especially those having a malarious origin, can be more easily cured by sending the sufferer to a site some 500 feet above the source of the malaria. In tropical regions 1,500 feet is sometimes required. Even in such positions it is necessary to avoid places which may be exposed to drifting malaria, just as it is always advisable to avoid the side of a hill which is so situated as to be covered with smoke from a neighbouring town. When elevation cannot be obtained, then malarious places must be remedied by draining and filling up bogs and swampy places, and covering the soil with herbage, and keeping the fodder thus provided well utilised; a well-cultivated marsh is safer than one in which vegetation is neglected. It is also advantageous to plant belts of trees, so as to intercept the poison and cause its consumption by vegetable life, and for this purpose evergreens are invaluable, as they are greater protections when most wanted.

It is always advisable to place sick persons who have diseases caused by epidemic influences at the top of the house, so that the infective germs which they may distribute may be exposed as much as possible to atmospheric influences, and be more certainly rendered abortive. I have been told by an experienced sea-captain, who sailed Messrs. Green's ships for a great number of years, that whenever small-pox broke out among his passengers (which was the case on several occasions when conveying emigrants to Australia) that he was accustomed to sling them in hammocks as high as possible in the rigging, with awnings to protect them from sun and weather; that they always did well, and in no instance did he find the disease extend among the passengers when the case was discovered early enough. This account was corroborated to me by another of the merchant captains belonging to the same service. The germs were blown overboard, and did not affect those on deck. It is probable that the influence of an ozonised atmosphere upon disease germs is to destroy their vitality, and thus diminish the incidence of the disease by making the disease germs unfruitful.

The prevailing winds must be considered when fixing upon sites for infectious wards, and when possible they should be so placed that emanations or miasms may be blown from the building towards an uninhabited position; and *vice-versa*, no hurtful influence should be allowed (when such a course is possible) to be brought by the wind into the area occupied by the building. I think an island a mile away from the shore is the most appropriate place, when it can be obtained, for the erection of infectious wards for those towns which have a sea board. Next to that, a properly-fitted vessel moored at the same distance from the land, will be safer, and more capable of being isolated than any camp on land.

Sea breezes tend to bring health to land, because the air from the sea is always more or less ozonised in temperate climates. These breezes vary on different coasts; their influence should be studied, and their incidences registered. The wind will often blow from the sea for a short time in the twenty-four hours, according to the state of the tide, although a few miles inland the wind may be in the contrary direction. Sea air does not suit all kinds of constitutions at all times. It frequently tends to render bilious people out of sorts. I have known an immense number of people suffer seriously from its effects, because they have been ill-advised. They go away for a change to the seaside in consequence of not feeling well. They get a better appetite, but they do not carry off the *débris* which results from it by extra exercise; they saunter on the shore, or ride about doing nothing; their constitution becomes loaded with the result of excessive food, and when they return home (or sooner) they break down with bilious fever, or some kind of liver disease, or with an attack of gout, which would not, perhaps, have arisen if they had eaten less and done more work. It is unwise for such constitutions to seek the sea-coast until after they have undergone a personal house-cleaning; they should then be moderate in their repasts and active in their habits if they wish to get the benefit which a sea-air will afford them.

The time of year and the character of the season should be considered. It is not advantageous for those living inland to go to the south coast in July and August. The south is most useful in the spring, or when the leaves begin to fall from the trees, and the air of inland places becomes loaded with the results of decaying vegetation. This influence affects human beings to some extent, and those who wish to get the greatest advantage from change of climate, would find it when going to the south coast to delay their visit to October and November, rather than to take it in July and August. In the hot season it is much better to go on to the moors, to the west coast, to the north of the Thames, than to the south coast. But the lake district is very relaxing in hot seasons, and if a visit to the lakes is not attended by muscular exercise, such as climbing to the hill-tops, the change will often be disadvantageous to those indulging in it. The east coast is free from this disadvantage, and a trip to Scarborough, Whitby, or Filey in August will contrast most advantageously in its effects upon such constitutions with a residence at Brighton, Eastbourne, Torquay, or Penzance in the same time in the year. The prevailing winds will be determined by the surroundings. The west coast of Ireland is influenced by the broad Atlantic. The east coast of England, for a similar reason, has a succession of dry east winds of longer duration than those which are felt in the west. The east winds coming from the steppes of Russia are dry; those from the Atlantic are more likely to be loaded with moisture. Those from the north are more often cold than wet, but every country will vary according to its own surroundings.

The neighbourhood of a marsh is felt very decidedly when the wind blows from the marsh towards an inhabited place. The air will have an excess of CO_2, it will be moister, H_2S may be given off by the marsh as well as H_3P. The miasms which give rise to ague are thought to depend upon a bacillus, which may be carried by the wind, though evidence is not sufficiently strong upon this point to make it certain. The effect from salt marshes is not so serious when

they are occasionally covered by sea-water, the miasms from peaty soil which is only occasionally flooded is the most noisome, especially if the storm water is likely to bring down animal excreta and dead animal matters.

The prevailing winds will be made out by observing the angles made by the trees with the surface of the ground. This may be more easily observed on the sea-coast. The trees and shrubs in a copse or hedgerow will be observed to lean away from the point from which the wind blows most continuously, and the nature of the wind may be gathered from the geographical nature of the earth in the point from which the wind blows.

The prevalence of cloud will be affected by the same causes. The wind from the Atlantic is loaded with moisture, if it impinges upon high land such as the Irish or Welsh mountains, the colder earth condenses the moisture and the ranges of hills are covered with dense masses of vapour which gradually break away, and form clouds in the more inland regions. It is also found that great cities such as London in which immense quantities of coal are burned into carbonic acid, and vapour, assist to produce more cloud on their leeward side than on that from which the wind blows, and by that means there is a diminution of direct sunlight. The west side of a mountain has more sunlight than the east, because more moisture comes from the former quarter; it is not condensed until after it has impinged upon the cold surface of the hills, and clouds are manufactured, so to speak, which have their points of origin in the colder strata of the mountain tops; and from those points streams of clouds are detached which assist to develop rain in the interior of the country, so that there is a greater rainfall on the western coast of Great Britain than on the east, because it is in the west that the mountain ranges are found.

(*To be continued.*)

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The New Class-Subject, 'Elementary Science.'

(*What to teach, and how to teach it.*)

BY RICHARD BALCHIN.

(*Continued from page* 200.)

SINCE I began writing these notes of lessons on the above subject for Standards VI. and VII., of which the detailed syllabus appeared in the June issue of this magazine, I find that the School Board for London has decided to put up, not only chemical laboratories in some schools, but also to fit and furnish workshops—as at Beethoven Street—where, under a practical workman, the boys may be taught the use of tools and of such mechanical contrivances as the lathe, forge, etc. The course of lessons I am now formulating will be found exactly suitable for the boys in the upper standards of such schools, where either 'Elementary Science' is taken as a class-subject, or 'Practical Chemistry' as a 'special.'

Continuing the notes from last month's issue, we have:—

LESSON XVI.—DISTILLATION.

The boys should construct a Liebig's condenser, of which an illustration appears on page 99 of Thorpe's 'Inorganic Chemistry,' Collins' Advanced Series. The teacher will, of course, make one in class before the boys, and then, giving out the necessary tubes, corks, and bottles, send the lads into the workshop to construct their own. As an exercise in the use of the condenser the boys may separate the spirit from a little strong ale, and then prepare a bottle of distilled water for future use.

LESSON XVII.

Each boy should make his own test-tube stand, and cut out a number of small blocks of wood to be used as supports and elevators. If there is a lathe in the workshop the boys may turn their own small wooden pillars. The stand should have about eight holes of various sizes. It would be well for the teacher to print off from the hectograph a number of illustrations, drawn to scale, of such a stand, and set the boys to construct theirs from the drawing. If the boys have been taught to draw to scale, they can make their own drawings and work from them.

LESSONS XVIII. TO XXI.

The notes on infusions and solutions are given sufficiently in detail in the syllabus. In each case the teacher should first make the preparations in the class-room before the boys.

LESSON XXII.—FILTRATES.

From the combination of some of the solutions described in the last lesson, we obtain certain precipitates. These may now be separated by filtration and evaporation. When dry, the powders should be placed in pill-boxes and labelled. In this way small quantities of the following compounds are prepared, viz., iodide of mercury, of a brilliant scarlet colour; iodide of lead, yellow; sulphide of lead, black; sulphide of zinc, white. The teacher should prepare a filtrate before the boys, thus:—Weigh out a certain quantity of lime-water. Breathe into it, and so form calcium carbonate. Weigh again: note the increase. Weigh a filter paper. Filter out the carbonate. Dry, and again weigh; compare with the increase before noted. Or, wash the filtrate from the paper into an evaporating dish. Evaporate and weigh. Put the residue into a pill-box and label. Let each boy do the same. Simple experiments of this nature teach the boys more of chemical manipulation than any quantity of mere lecturing about it. It is a kind of advanced Kindergarten work. The boys actually see something being done which they themselves can easily accomplish.

LESSONS XXIII. TO XXVIII.

The facts and the methods of presenting them are given with sufficient detail in the syllabus, or can be obtained from any elementary work on chemistry, so need not here be repeated.

LESSON XXIX.—LIME.

For the preparation of lime by calcining fragments of white marble, an iron retort is not absolutely necessary. I have generally used an iron plate, about three inches by two, covered over with a small arch of wire gauze. Into this little tunnel or arched-roof chamber I place the pieces of marble, and put the whole into a hollow part of a clear, bright fire. In about half an-

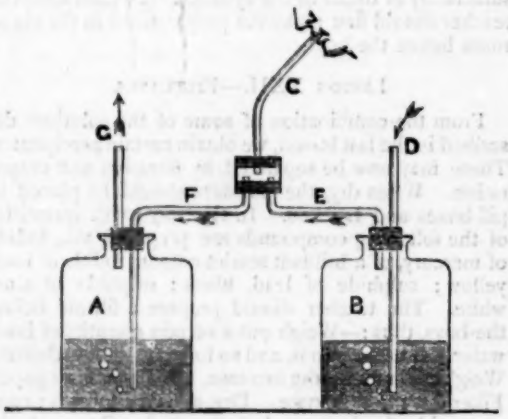
hour the lime is formed. The weight of the carbonate (*i.e.*, the white marble) should be compared with the weight of lime produced, and the difference explained. Each boy should have on the shelf of his bench a bottle of fragments of white marble, and one of lime obtained by calcining the same.

LESSONS XXX. TO XXXIII.

The notes given in the syllabus, together with the articles by Dr. Aveling, now appearing in this magazine, furnish all the necessary information for these lessons.

LESSONS XXXIV. AND XXXV.

The apparatus for showing the effect by the exhaled air from the lungs upon lime-water, requires to be carefully constructed. Get a piece of glass tube one inch and a quarter in bore. Cut off a two-inch length with a file. Fit corks into each end; make one perforation in one cork, and two in the other for glass-tubing. Have two wide-mouthed bottles. Fit into the necks of these corks, each with two perforations. Then bend your glass tubing, and fit up, as seen in the illustration.



A and B are two bottles, each half filled with lime-water. The operator first inhales or draws in a breath through the tube C. In so doing, atmospheric air passes into the tube D and through the lime-water in B, of course without affecting it, and then along the tube E. This air having traversed the air-tubes of the operator's lungs, is exhaled or breathed out, also through the tube C; but it passes along the tube F into the lime-water in A, and so out at G. After alternately inhaling and exhaling for a few minutes, the liquid in A becomes milky, through the formation of calcium carbonate, which is insoluble in water. The lime-water in B remains clear. If the respiration be kept up long enough the liquid in A gets clear again, in consequence of the formation of calcium bicarbonate, which is soluble in water. Instance the clear spring-water issuing from the ground in chalk districts. Or a little of the milky-looking liquid may be placed in a test-tube and a few drops of hydrochloric acid added, when the clearness at once returns, owing to the formation of calcium chloride, which is also soluble in water; the carbon dioxide may be seen escaping in small bubbles.

I may add that if simple water be used instead of lime-water, this apparatus forms an excellent means of illustrating the pressure of the atmosphere; for the whole rationale of its action depends upon the production of varying atmospheric pressures.

LESSONS XXXVI. TO XXXVIII.

Here again the reader will find that the notes given in the syllabus, together with Dr. Aveling's articles, afford all the information needed for these three lessons. It is very essential that the boy, after having finished the practical work sketched in the notes, should describe clearly in his exercise-book what he has done, under these three heads:—1st, How I made the element or compound; 2nd, What experiments I performed with it; and 3rd, What those experiments taught me. The young student is thus early led to see that all real knowledge is founded upon experiment and observation.

LESSONS XXXIX. AND XL.

The lessons upon the combustion of a candle may be considered to involve a recapitulation of nearly all that has been taught the boys in this subject of Elementary Science. I am reminded of a saying of Linnæus, that if he only understood everything connected with the growth of a simple primrose, he would be in a position to understand all the facts and phenomena of nature.

The following simple apparatus should be constructed:—1st, By the teacher in class; and 2nd, by the boys in the workshop. It will show in a striking manner the formation of at least two of the compounds resulting from the combustion of a candle. It must be made clear to the boys that we are now dealing with three elementary bodies, viz., the carbon and hydrogen of the candle, and the oxygen of the air. There are, strictly speaking, more than these three concerned, but the others are small in quantity, and can for the present be left out of consideration. Get an ordinary paraffin lamp-glass or funnel. The candle is to burn in this: the lower part is, of course, left open for the admission of air. The upper small part of the glass is closed with a cork, with one perforation for a length of glass tubing. This tube, after leaving the funnel, is bent over and downwards, and so into a larger tube filled with lime. Out of the lime tube passes another small tube, passing upwards, and then over into a wide-mouthed bottle containing lime-water. The end of the tube should dip into the lime-water. Out of the lime-water bottle passes another piece of glass tubing; this piece does not dip into the water, but passes upwards, and then over, through the bung of a stoneware gallon jar. The gallon jar is filled with water, and has a stopcock at its lower part. When the lime tube and the lime-water bottle have both been filled, the whole apparatus, with the exception of the gallon jar, should be accurately weighed; *i.e.*, the number of grams or grains of lime, of lime-water, weight of funnel, tubes, etc. The candle is now lighted and passed up the funnel. At the same time the stop-cock of the stone jar is turned on a little, and of course water runs out, when the alteration of atmospheric pressure thus produced causes the air necessary for the combustion of the candle to pass up into the funnel. The union of the carbon and hydrogen of the candle with the oxygen of the air results in the formation of, first, water, H_2O,

which is arrested in the lime tube, hydrating the lime; and, second, of carbon dioxide CO_2, which forms, with the lime of the lime-water, calcium carbonate. After the candle has burnt out, the whole apparatus should be again weighed and the difference, if any, noted.

This article completes the series on the new class-subject, 'Elementary Science.' I have, with great satisfaction, learned that in consequence of the appearance in this magazine of these lessons, many teachers in various parts of the country have been led to take up the subject, and have found it to be a benefit to their scholars. I take this opportunity of thanking those of my fellow-workers who have from time to time written to me either letters of congratulation, or, what has been of more value, letters criticising or correcting some of my statements. In taking leave of my readers, I can only express a sincere wish that the work of science-teaching will progress, for I believe it to be one of the greatest educative influences which we possess.

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Lectures on Shakspere's 'Tempest.'

BY H. MARMADUKE HEWITT, M.A., LL.M.,

Late Assistant-Examiner in Classics in the University of London.

No. VI.—ACT III., SC. 3, AND ACT IV., SC. 1, LINES 1—120.

(The figures in brackets refer to the pages of the Clarendon Press Edition.)

OUR scene lies in an another part of the island. Poor Gonzalo, like good old Adam in 'As You Like It,' is on the point of giving in, and protests by the Virgin Mary (*By'r lakin*) that he can go no further.

He complains that the way lies through '*forthrights and meanders*,' which are much the same thing as 'straight paths and crooked courses.' The word *meander*, as most scholars know, has got its own little history. It was originally the name of a river of Phrygia, with an unusually winding and tortuous course; and so, as time went on, the name passed into a verb, so that 'meander' and 'wander,' or 'wind about,' became almost synonymous expressions.

This is not the only classical allusion; a little further on we find a reference to the phœnix—the fabulous bird which, besides other wonderful characteristics, was supposed to depend for its life upon the continued existence of a particular tree, dying when the tree died, and flourishing while the tree remained in health and vigour. When Alonzo, like his companion, is 'fain' to confess himself tired, he speaks of himself as '*attached with weariness*.' *To attach* means 'to seize,' but is properly a legal expression, rather than a word in ordinary use. We may explain it somewhat as follows:—Suppose A owes money to B, and C has got some money belonging to A, or owes A a debt; then B may, under certain circumstances, get a court of law to compel C to pay the money to himself, instead of paying in to A—and this is called 'attaching' the money. It has been noticed, by the way, that Shakspere knew a good about the law. I have seen a question in an examination paper which required the candidate to make a list of the distinctly legal phrases and allusions to English law which occur in the various plays of Shakspere. '*To the dulling of my spirits*' may be paraphrased by the words, 'so as to produce a feeling of dullness.' We need scarcely stop to notice the expression '*frustrate search*,' our previous studies having made us acquainted with many of these abbreviated participles. '*They will not, nor cannot*,' is, of course, an equivalent for 'They will not and cannot,' or 'They neither can nor will.'

We are all familiar with the rule that in modern English 'two negatives make an affirmative.' In Shakspere's time a second negative was supposed to make the denial more emphatic. *A living drollery* (45) is well explained in the Clarendon Press notes. We will only add that the shows called 'drolleries' were performed in Shakspere's time by puppets only. '*What does else want credit*' is much the same as 'Whatever else is regarded as incredible.' The following line appears to have one syllable too many:—

'And I'll be sworn, 'tis true: travellers ne'er did lie.'

Count the syllables, and you will find that this is the case. Two emendations have been suggested. Either substitute *to 't* (*i.e.*, to it) for *'tis true*, or else write *lied* instead of *did lie*. In both cases the word *travellers* is a dissyllable.

Notice the long statement beginning with '*Who, though they are of monstrous shape*.' The peculiarity of this passage is that *who* has got no verb. It is, in fact, the nominative to nothing at all, and has just as much meaning as the 'which' of Mrs. Sarah Gamp. Leave out *who*, and the sentence is much clearer. *Gentle-kind* is a curious compound-adjective, but there are many such in Shakspere. '*Childish-foolish*,' '*senseless-obstinate*,' and '*mortal-staring*' all occur in the play of 'King Richard III.' A little further on, the verb *muse* has the meaning of 'wonder at.' '*Praise in departing*' means 'Don't praise too soon.' The word *praise* ought, we think, to be parsed as a verb in the imperative mood. *Taste* in '*Wilt please you taste*' is, of course, in the infinitive. By '*mountaineers dew-lapped like bulls*' our poet means peasants afflicted with the goitre, an enormous swelling of the throat, which is not uncommon in Switzerland, even at the present time. It is supposed to be the effect of drinking 'hard' water, or water impregnated with limestone. Now comes the expression, '*Each putter-out of five for one*,' which has given great trouble to the commentators. The words mean, 'Each (traveller), who puts out his money (*i.e.*, before leaving home), on condition of receiving five for one (*i.e.*, five times as much as he), in case he returns safely.' But, you may say, this is putting out 'one for five,' not 'five for one.' Quite true, and some believe that the words were written so originally. If the present reading stands, then 'five for one' means five returned for one advanced or deposited, and the words 'money at the rate of' must be understood after 'putter-out of.' In the course of Alonzo's next remarks, *I will stand to* means 'I will take a place at the table'; *although my last* means, perhaps, 'though this should be my last mouthful'; and *the best is past* = 'I have seen my best days,' or 'the best of my life is over.'

We need not offer any explanation of the words, 'like a harpy.' The Classical Dictionary tells us all about

these fabulous creatures, who are mentioned, moreover, in the Third Book of Virgil's 'Æneid,' and also by Milton. '*Destiny*,' Ariel asserts, '*hath this lower world to instrument*.' This means that destiny makes use of the events of this life in order to carry out its high designs, such, for instance, as the punishment of treachery. *To instrument* is the same as 'for instrument.' The note in the Clarendon Press edition tells us to compare the passage in the Second Act—'*Such a paragon to their queen*.' Notice that the verb *inhabit* is here used without an objective case after it, and with the meaning of 'dwell.' '*Of which your swords are tempered*' is the same as 'of which your swords are composed.' When Ariel says the swords '*will not be uplifted*,' he means that they will be restrained by some magic influence. This idea is common in the mediæval stories of men who have fought duels either with the devil or some one who has covenanted for his assistance.

You will notice, within a dozen lines or so of each other, two unusual plurals, viz, *strengths* and *wraths*, the plural form being used to indicate the strength of each (man), and the wraths of each (of the powers). We may notice, too, *distractions*, about ten lines further on. The idea of repentance and an innocent life finds expression in '*heart-sorrow and a clear life*.' The meaning of *clear* is, of course, metaphorical. 'A clear life' is an unusual expression, though we see nothing remarkable or unintelligible in 'a clear conscience.'

Prospero congratulates the spirits on the manner in which they have carried out his orders. He says that his meaner ministers *have done their several kinds*, that they have done so *with good life* and *with strange observation*. We must endeavour to make these expressions a little clearer. What is it that they have done? They have taken various half-human forms, and acted their parts very naturally. *Done their several kinds*, therefore, means 'discharged the various functions allotted to them.' They have done this *with good life*, that is, 'with great fidelity to nature,' and '*with strange observation*,' *i.e.*, with wonderful regard for what is proper and appropriate. We have explained 'with good life' as equivalent to the well-known expression, 'to the life,' but possibly it may mean 'with alacrity'; for one commentator makes the assertion that 'to do a thing with good life' is equivalent, in the dialect of the West of England, to doing it with full bent and energy of mind. On this statement, however, we cannot place much reliance. '*Mine enemies are all knit up in their distractions*' seems to mean that they are 'entangled in confusion,' or 'entangled in their feelings of consternation and bewilderment.' To 'knit' is originally 'to form into a knot,' and will readily bear, we think, the interpretation we have suggested.

Bass my trespass = 'Tell me of my sin in rough, bass tones.' The speaker hears in the thunder the voice of an offended Power.

Bite the spirits might mean either 'prick their conscience' or 'goad them to desperation.' *Ecstasy* (48) we may remark, has the two meanings of 'rapturous pleasure' and 'mental alienation.' The latter meaning is the one it appears to bear in this quotation.

ACT IV.

The opening remarks of Prospero contain many familiar words that appear in an unusual sense.

Too austerely = 'with too great severity.' The original meanings of *austere* (harsh, dry, sour, rough to the taste) are such as lend themselves very naturally to a metaphorical sense. Mr. Ogilvie says the same root is contained in the word *sere* ('sere and yellow'). *A thread of my own life* means, not 'a third,' but 'a branch or offshoot,' and, of course, refers to Prospero's daughter, Miranda.

We need not again speak of *who* being written instead of *whom*. This has occurred more than once already.

The adverb *strangely* has the same meaning as the French *merveilleusement*, or the English expression, 'wonderfully well.'

Notice that *sanctimonious* here means 'sacred.' In modern English, however, a 'sanctimonious' person is one who makes a false or hypocritical pretence of sanctity. *Sanctimonious*, therefore, is a word that has undergone a 'deterioration' of meaning.

Aspersion, which here means 'sprinkling,' has now-a-days the meaning of 'calumny' or 'detraction.' The phrase is metaphorical, something like 'throwing dirty water over' a person.

Notice the expression '*Fairly spoke*.' By counting the number of syllables, you will perceive that *fairly* is pronounced as a trisyllable (*fa-ir-ly*), and the same is true of *vineyard*, on the next page. By *rabble* Prospero means the crew of inferior spirits.

Some vanity means 'some illusion.' The reader may have noticed that *presently* bears a different meaning in different parts of England. Sometimes it stands for 'immediately' (as here), and sometimes for 'after a little time,' or 'by and by.'

Ariel says, '*Well, I conceive*,' instead of 'Well, I understand.'

Bring a corollary (50) means 'Bring too many, rather than let there be too few.' A *corollary* means a supernumerary.

'*No tongue!*' is much the same as 'No noise!' or 'Let the tongue utter no sound!' All were silent in incantations. If a word were uttered it was supposed that the spell was broken.

We wish that we could declare that '*peonied and lilied brims*' were certainly the true reading, instead of '*pioned and twilled*.' 'Banks fringed with peonies and lilies' is certainly so much more poetical than 'banks dug, and besmeared with mud.' Read the long note in the Clarendon Press edition.

In *spongy April* means, no doubt, 'wet' or 'soaking,' and refers, of course, to the April showers, which, somehow, do not reach us now before the month of May.

The pole-clipt vineyard is an awkward expression. If *pole-clipt* means 'pole-embraced,' or 'pole-embracing,' the whole expression must mean 'the vineyard in which the vines embrace the poles.'

When Iris says, '*Whose watery arch and messenger am I*,' it must be remembered that Iris is the name both of the rainbow-goddess and the rainbow itself.

Bosky acres are 'woody acres,' or 'acres of forest,' and when the *unshrubbed down* is called '*rich scarf to my proud earth*,' the meaning intended is that it forms a beautiful natural border to the cultivated fields. Fields and hedges, when viewed from a great elevation, have sometimes quite an artificial appearance, like patchwork, or some fabric of dress material.

Why does Ceres object to the presence of Venus?

The reason is, according to the fable, that Dis (or Pluto) had carried off Ceres' daughter (Proserpine) to Hades, to be his wife. As this was a love affair, Venus was answerable for the transaction, and hence the bereaved mother objects to meeting Venus and her son Cupid. Shakspere, you see, has got the classical mythology at his fingers' ends. Paphos was a city of Cyprus, dedicated to, and especially identified with, the worship of Venus.

'*Great Juno comes; I know her by her gait.*' Juno's manner of walking was distinctly dignified. Most schoolboys will recollect the line of Virgil's First 'Æneid' which begins, '*Ast ego quæ incedo,*' and which Anthon translates 'But I, who walk majestic.' We have a hyperbole in the lines where Ceres wishes that spring may come almost before harvest is ended. The words *harmonious charmingly* are an evident inversion of 'charmingly harmonious.' There is a passage in Shirley's 'Young Admiral' where *valiant truly* is put for 'truly valiant.' All that we can say is that the usual positions of the adjective and qualifying adverb are inverted in the two expressions.

The extreme fertility of certain favoured districts, as, for instance, the rich plains of North Italy, which admit of a plurality of crops in a single year, may, perhaps, seem to give a certain amount of literal reality to the wish that spring might tread on the heels of harvest. Most likely, however, Shakspere never troubled himself to ascertain how far this was actually possible. His wish was to embellish his language rather than to call attention to a natural fact. Perhaps, too, the poet did not quite believe in the existence of men 'whose heads stood in their breasts.' But the allusion fits in very conveniently. As regards both manner and matter, a good deal is allowed to 'poetic license.'

(*To be continued.*)

—o—

Matriculation Examination

June, 1885.

English Language.

1. Dictation passage.

2. Teutonic and Classical.

(1) *Teutonic.* English belongs to the Indo-European, or Aryan, family, in common with most of the languages of Europe, and some (Persian, Afghan, *e.g.*) of Asia, and to the Teutonic group. Of this group there are three divisions: Low German, Scandinavian, High German. The people belonging to the first of these divisions lived formerly near the low-lying lands by the mouths of the Rhine and the Elbe. There are six languages grouped under the name Low German. These are the dead Gothic and old Saxon, once spoken in Dacia and between the Rhine and the Elbe respectively; English and Lowland Scotch; Frisian, spoken between the Scheldt and Jutland, and on the adjacent isles; Dutch (Holland); Flemish, once the Court language of Brabant. The English language was brought into Britain about the middle of the fifth century by the Low German tribes known as Anglo-Saxons and Jutes (Frisian).

(2) The *Classical.* Latin, either directly or indirectly, through the French, is, of all the foreign sources of our language, the most fruitful. (*a*) Directly. During the Roman occupation of Britain, from A.D. 43 to 426, certain names of places and military terms came in (Doncaster, Lincoln, legion). With the introduction of Christianity, about the year 600, Church words were introduced (monk, minster.) Constantly, from the time when learning began to revive, classical words have been taken directly into the language for use in philosophy and natural science. (*b*) Indirectly. The Norman invasion, the close relations between England and France in the 11th, 12th, 13th, and 14th centuries, the frequent translations from the French, led to the introduction of many Latin words through that language.

Our grammar comes from the Teutonic source almost exclusively. The Teutonic is an inflected group of languages. The Danish and French are non-inflected languages. Both of these have done much in modifying the inflections of the original tongue. The *n* of the infinitive mood was dropped before the Norman Conquest; and the ending *es* for the 3rd per. sing. present indicative substituted for *eth*. The natural tendency of a language to pass from the inflected to the non-inflected condition was, in England, hastened by the influx of French. The old genitive *s* was partly replaced by the use of the pre position *of*; *more* and *most* were used in the comparison of adjectives as well as *er* and *est*.

3. Cognates are words in one language that are parallel to, but not derived from, similar words in another. Frater (Lat.), Bruder (Ger.), brother (English) are all cognates. Derived words are those in which a certain root is modified by some suffix. 'Fraternal' is derived from 'frater.' Cognates of the word *bear* are Gebaren (Ger.), porter (Fr.), fero (Lat.). Derivatives are 'bearable,' 'boredom.'

4. *College*—of classical origin, from *cum*, together, and *lego* (legĕre), I collect, or perhaps with the sense 'I read.' *University*—classical, from *universitas*, a noun formed from the adjective *universus* = whole, altogether. *Degree*—classical, from *degredior*, *degressus sum* = I descend. At the end of a university career one descends through a degree into the world. *Examine*—classical, from the noun *examen* (and that from the verb *examino*), a weighing, a consideration. Primary derivation *ex* = out of, *animus* = mind. *Student*—classical, from *studeo* = I am eager, I study. *Scholar*—classical, from *schola* = a school. *Pass*—classical, from *passus* = a step. *Fail*—classical, from *fallo*, *fefelli*, *falsum* = I make to fall, or slip. *List*—directly French, *cf.*, *liste*. *Matriculation*—classical, *matrix*, a female parent, and so a parent stem.

5. A letter is a sign for a sound.

C is a redundant letter in our alphabet. It may be represented by *k* before the vowels *a*, *o*, *u* (as in cat, cot, cut), and by *s* before the vowels *e*, *i*, *y* (as in Cecil, lunacy). With *h*, as in 'loch,' it represents a sharp guttural, or a peculiar partly dental, partly sibilant sound in 'church.'

There are three sounds represented in English by *u*. The three words, 'but,' 'bull,' 'university,' illustrate these sounds. In the first we have a short, sharp sound; in the second a long, soft sound, comparable with the *oo* in 'wood'; in the third, *u* is only a semi-vowel, having the same sound as if a *y* were prefixed; *cf.*, the word 'youth.' Hence it is correct to write 'a university,' not 'an university,' just as we write 'a youth.'

6. *Inflection* is the name for the changes that words undergo to mark number, gender, case (in nouns), comparison (in adjectives), voices, mood, tense, number, person (in verbs). *Analysis* is taking to pieces. An analytical language is a non-inflectional one. Analysis has also another meaning—that of taking sentences to pieces, as in logical or grammatical analysis. *Synthetic*, from *sunthesis* = putting together. A synthetic is an inflexional language. *Interjection*—an exclamation, hardly a true part of speech. *Strong* verbs are those that form their past tenses by a change in the root vowel, as 'come,' 'run.' *Weak* verbs are those that form their past tenses by adding to the root of the present *d* or *t*. The strong verbs are Teutonic, the weak classical, in their origin.

Abstract nouns are names of qualities, as 'goodness.' *Concrete nouns* are names of persons, places, substances, as man, town, wood. A *simple* sentence contains one finite verb, *e.g.*, 'The boy runs,' or 'The boy is stupid.' A complex sentence is one form of the compound sentence. The latter contains two or more simple sentences. If these are merely co-ordinated, that is, placed side by side without any dependence of one on the other, as in 'The boy runs, and is stupid,' they are not called complex. This name is only applied to compound sentences containing a principal simple one, with one or more other simple ones subordinate to it, *e.g.*, 'The boy runs that he may see the show.'

7. (1) Those of Teutonic origin. *Er* (speaker) = doer, *l ng* = l-ing (darling), *kin* = k-in (lambkin), *ock* (hillock)—are all diminutives. *En* (vixen) and *ster* (spinster) are feminine endings. *Ness* and *th* (goodness and wealth) are abstract noun-endings.

(2) Those of Classical origin—*age* (coinage), *ance* (countenance), *l-ence* (violence), *ment* (treatment), *sion* (vision), *tude* (multitude)—are abstract noun-endings. *Ar* or *er* (cellar or garner) denotes place where, or (vicar or baker) agent. *Erel* (cockerel), *icle* (particle), are diminutives. *Ess trix* (actress, executrix), are female endings.

8. *Brethren*, a plural form of brother, made (1) by a vowel change, *o* becoming *e*; (2) by adding the old plural ending, *en*. It is only used for the brothers of a community, not for brothers by blood. *Seamstress*, seam-ster-ess. *Ster* is the old feminine ending for one who 'seams' or sews. *Ess* is a classical female ending added on to the older one. *Indices*, plural form of 'index.' This word in the sing. has two meanings: the index of a book, with plural *indexes*, and an algebraical sign to express the power to which a quantity is raised, with plural *indices*. *Fisherman*, a word of masculine gender, where the ending 'man' is used to denote the male sex as opposed to 'woman' in fisherwoman. *Cherry*, a word cognate with the French *cerise*; Lat., *cerasus*; Ger., *Kirsche*. *Kine*, a double plural of 'cow,' by modification of the vowel (*o* to *i*) and addition of *en*. *Swine*, a word of the same form in the sing. and the plural numbers; possibly first formed as plural by adding *en* to 'sow.' *Cherubim*, a Hebrew pl. in *im* of 'cherub.' *Riches*, a singular noun, with a simulated plural-ending, from the French *richesse*. *Uttermost*; out (old Eng., 'ut'), makes the comparative *outer* and *utter*. To this has been added the suffix *most*, containing the two superlative endings *mo* and *est*.

9. A pronoun is generally a word used instead of a noun, as 'he' or 'that.' A relative pronoun carries back (referro, rettuli, relatum) the mind to some subject previously expressed. That subject is called the antecedent (the going before). *Who* is used in reference to persons in the nominative (who) and accusative (whom). In the genitive (whose) it may be used in respect to persons and things—'Who are you?' 'Whom did you meet?' 'Whose book is that?' 'That undiscovered country from whose bourne.' *That* is used of persons ('the woman that nursed me') and of things ('the book that I read'). *Who* is more generally used to direct attention to that which follows ('I saw the man who told me'). *That* is more generally used to direct attention to that which precedes ('I saw the man that was with you yesterday'). *Who* generally introduces a co-ordinate sentence ('Breathes there a man with soul so dead, who never to himself has said'). *That* generally introduces a subordinate sentence ('They are wise men that live moderately').

10. *Verb.*	*Conjugation.*	*Past Ind.*	*Past Part.*
See.	Strong, III.	Saw.	Seen.
Saw.	Weak, III.	Sawed.	Sawn.
Say.	Weak, II.	Said.	Said.
Sow.	Weak, III.	Sowed.	Sowed, or sown.
Sew.	Weak, III.	Sewed.	Sewed, or sewn.
Sue.	Weak, II.	Sued.	Sued.
Set.	Weak, I.	Set.	Set.
Sit.	Strong, II.	Sat.	Sat.
Seethe.	Weak & Strong III.	Seethed or sod	Seethed or sodden
Sell.	Strong, II.	Sold.	Sold.

The figures I., II., III. refer to the classification of verbs into (i.) with the same form for all the three principal parts, (ii.) with two forms, (iii) with three forms.

11. The first of the verbal nouns is the infinitive mood. This is an abstract noun. At first with the old ending *an*, this was followed by *en*, *e*, and finally this *e* was dropped, and only the preposition *to* marked the infinitive mood. This is the uninflected infinitive ('I want to speak').

The second is the dative, or gerundial infinitive. This was governed by the preposition *to*, and had the suffix *e*. It is used to express purpose ('What went ye out for to see?').

The third is the verbal noun in *ing*, corresponding with the Latin *gerund* ('Parting is such sweet sorrow'). This ending is from the old English *ung*, and must not be confounded with the *ing* of the present participle from the old English *end*.

The verb 'worth' has the meaning of 'to be.' It is connected with the German *werden*, to become. The verb 'to be' takes the place of the verb 'to have' in the perfect tenses of intransitive verbs. ('He is gone,' for 'He has gone'; 'If he were come,' for 'If he had come.')

12. He is at (to) home. He looks at (on) me. He aimed at (towards) the mark. With (Latin, *cum*) pleasure. He is with (German, *bei*) me. The love of (from) a mother. The love of (towards) a mother. He came from (of place) London. It resulted from (of cause) an accident. He ran against (contra) me. I am against (opposed to) that.

'By' here has the meaning of 'towards.' 'Under' is 'in.' 'To' in the former case is 'against' (contra). 'To' in the latter is 'plus' (Latin, *ad*). 'For' is 'on account of' (Latin, *ob*).

13. *After.*—Sentence 1—An adjective, sing., neuter, nom., agreeing with 'life.' Sentence 2—A contraction for 'Go after.' Verb transitive, act., imp., sing. or plural, the 2nd person. Sentence 3—Adverb of time, qualifying the verb *came*. Sentence 4—Adverb of place, qualifying the verb *come* Sentence 5—Preposition, governing *that*. *Out.*—Sentence 1—A contraction for 'Go out,' verb intransitive, active, imperative, sing., 2nd person. Sentence 2—Adjective, positive, sing., mas., nom., agreeing with *he*. Sentence 3—Interjection. Sentence 4—Adv. of number, qualifying *he was beaten*. Sentence 5—Adj., poss., sing., mas., nom., agreeing with 'deceiver.'

14. (*a*) The use of the two perfect tenses. The one, 'I had seen,' dependent on the other, 'I had hoped,' is inaccurate. 'To see' is the correct reading. (*b*) The 'which' is a little ambiguous, as it might refer to the *couple*, or the *dogs*. The use of *or* is more than ugly. The sentence should read: 'Had these not been returned to them, the breed would have died out.' (*c*) The latter part of the sentence is absolute nonsense. A 'quarrel' cannot be the 'most amiable,' or the most anything else of a set of things that precede it. (*d*) The present participle 'having,' in the first clause, ought to refer to the subject of the sentence. (*e*) *Am* cannot be the verb to 'you.' 'Neither you are nor I am right' would be better. (*f*) The second 'I' is wrong. It should be *they*. (*g*) The verb 'were' must have a nominative, not an accusative, for its subject. *Whom* should be *who*. (*h*) 'Whom' ought to be 'who.' The sentence really is, 'Who am I, do you say?' (*i*) 'Exists' ought to be 'exist,' as its subject, 'that,' refers to a plural noun, *works*. (*j*) The last clause is out of place. It qualifies at present the fault of 'finding.' It is meant to qualify the 'shooting.'

15. (*a*) A compound sentence. *I am monarch of all.* Subject, *I*; predicate, *monarch*; copula, *am*. Extension of predicate, *of all*; co-ordinate sentence, qualifying *all* (that which), *I survey*; subject, *I*; predicate, *survey*.

(*b*) A co-ordinate sentence. Principal sentence, *It is love.* Subject, *it*; predicate, *love*; copula, *is*; co-ordinate adj. sentence, qualifying *love, that makes the world go round.* Subject, *that*; predicate, *makes*; object, *the world*; adverbial phrase, qualifying *makes, go round.*

(*c*) Complex sentence. Principal sentence, *His business was to beat the enemy.* Subject, *business*; extension of the subject, *his*; predicate, *to beat the enemy* (a noun phrase); copula, *was*; co-ordinate sentence, '*He knew he could not beat the enemy*,' connected with the principal by the conjunction *and*. Subj., *he*; pred., *knew*; obj. A. (That) *he could not beat the enemy* (a noun sentence); subject of A, *he*. The predicate, *could beat*; obj., *the enemy*; subordinate sentence B, *unless he could get the officers*, connected with A, by *unless*; subj., *he*; pred., *could get*; obj., *the officers*; subordinate sentence to B is C (that) *it was possible to get*; subject of C, *that*; pred., *possible*; copula, *was*; extension of predicate, *to get*, an adverbial phrase qualifying the adjective *possible*.

Arithmetic and Algebra.

1. $\frac{4}{11}$ of a cwt. are chicory, $\frac{7}{11}$ of a cwt. are coffee.

1 cwt. chicory costs £2 12s. 6d.

$\frac{4}{11}$ " " £2 12s. 6d. $\times \frac{4}{11} = 52/6 \times \frac{4}{11}$

$= \frac{105}{2}\text{sh.} \times \frac{4}{11} = \frac{210}{11}\text{sh.}$

1 cwt. coffee costs £5 15s. 0d.

$\frac{7}{11}$ " " £5 15s. 0d. $\times \frac{7}{11} =$

$\frac{805}{11}\text{sh.} \times \frac{7}{11} = \frac{5635}{121}\text{sh.}$

Total outlay for 1 cwt. of mixture $= \frac{210+805}{11}$

$= 19\frac{6}{11}\text{sh.}$

He is to gain 20 p.c. upon outlay.

100 of outlay realise ∴ 120

1 " " $\frac{120}{100}$

$19\frac{6}{11}$ " " $\frac{120}{100} \times \frac{209}{11} =$

$\frac{6}{5} \times \frac{209}{11}$

$22\frac{18}{55}\text{sh.} = 110\frac{8}{11}\text{d.}$

$\frac{8}{11}$ of 1s. $= \frac{8 \times 12}{11}$ pence $= \frac{96}{11} = 8\frac{8}{11}\text{d.} = \underline{£5\ 10\text{s.}\ 8\frac{8}{11}\text{d.}}$

2.

$$\frac{1}{2} + \frac{1}{2.4} + \frac{1}{2.4.6} + \frac{1}{2.4.6.8} + \frac{1}{2.4.6.8.10} + \frac{1}{2.4.6.8.10.12}$$

$$= \frac{4.6.8.10.12 + 6.8.10.12 + 8.10.12 + 10.12 + 12 + 1}{2.4.6.8.10.12}$$

$$= \frac{23040 + 5760 + 960 + 120 + 12 + 1}{46080}$$

$$= \frac{29893}{46080}\,\Big|\,\overline{298930}\,\Big|\,\overline{\cdot 6487196180\&}$$

276480
224500
184320
401800
368640
331600
322560
90400
46080
443200
414720
284800
276480
83200
46080
371200
368640
256000
230400
25600

3. $\dfrac{\sqrt{3}-\sqrt{5}}{\sqrt{5}+\sqrt{3}} = \dfrac{\sqrt{3}-\sqrt{5}}{\sqrt{3}+\sqrt{5}} = \dfrac{\sqrt{3}-\sqrt{5}}{\sqrt{3}+\sqrt{5}} \times \dfrac{\sqrt{3}-\sqrt{5}}{\sqrt{3}-\sqrt{5}}$

$\therefore$ last expression is of the form $\dfrac{a-b}{a+b} \times \dfrac{a-b}{a-b} = \dfrac{(a-b)^2}{a^2-b^2}$

And $\therefore$ becomes $\dfrac{(\sqrt{3}-\sqrt{5})^2}{(\sqrt{3})^2-(\sqrt{5})^2} = \dfrac{3-2\sqrt{15}+5}{3-5}$

$$= \frac{8-2\sqrt{15}}{-2} = -4+\sqrt{15}$$

15(3·87294
9
68)600
544
767)5600
5369
7742)23100
15484
77449)761600
637041
1548984)6455900
6195936

$$-4+3\cdot87294 = -\cdot12706.$$

4. (1) $(x+y+z)^2 = x^2+y^2+z^2+2xy+2xz+2yz.$
$(x+y-z)^2 = x^2+y^2+z^2+2xy-2xz-2yz.$
$(x-y+z)^2 = x^2+y^2+z^2-2xy+2xz-2yz.$
$(-x+y+z)^2 = x^2+y^2+z^2-2xy-2xz+2yz.$
Their sum $= \underline{4(x^2+y+z^2).}$

(2) It will be best to get all the three denominators to the form $(x-y)(y-z)(z-x)$. All the fractions will therefore be multiplied by $\frac{-1}{-1}=1$, and will then read

$$\frac{-x-y}{(z-x)(y-z)}$$
$$\frac{-x-z}{(x-y)(y-z)}$$
$$\frac{-y-z}{(x-y)(z-x)}$$

$$\frac{-x-y}{(z-x)(y-z)} + \frac{-x-z}{(x-y)(y-z)} + \frac{-y-z}{(x-y)(z-x)} =$$
$$\frac{(-x-y)(x-y)+(-x-z)(z-x)+(-y-z)(y-z)}{(x-y)(y-z)(z-x)}$$
$$\frac{-x^2-2xy+y^2+x^2-2xz-z^2-y^2-2yz+z^2}{(x-y)(y-z)(z-x)} =$$
$$\frac{-2(xy+xz+yz)}{(x-y)(y-z)(z-x)} = \underline{\frac{2(xy+xz+yz)}{(x-y)(y-z)(x-z)}}$$

5. Let x represent the numerator, y " " denominator } of the fraction.
$\frac{x}{y}$ $\therefore$ represents the fraction.

$$\therefore \frac{x+36}{y+36} = \frac{2x}{y} \text{ (i)}$$
and $9x+8y = 3xy$ (ii)

From (i) we have, by cross-multiplication,
$xy+36y = 2xy+72x$
$\therefore\ 72x-36y = -xy$
$\therefore$ (multiplying by 3, and changing signs)
$-216x+108y = 3xy$ (iii)
Equating (ii) and (iii),
$9x+8y = -216x+108y$
$\therefore\ 225x = 100y$
$\therefore\ 45x = 20y$
$\therefore\ 9x = 4y$
$\therefore\ \frac{x}{y} = \underline{\frac{4}{9}}$

6. Multiply (i.) by 12 and $6x+4y+3z = 744$ (iv.)
" (ii.) " 60 " $20x+15y+12z = 2820$ (v.)
" (iii.) " 60 " $15x+12y+10z = 2280$ (vi.)
Eliminate x. Multiply (iv.) by 10 and (v.) by 3
$60x+40y+30z = 7440$
$60x+45y+36z = 8460$
$-5y-6z = -1020$ (vii.)
Multiply (iv.) by 5 and (vi.) by 2
$30x+20y+15z = 3720$
$30x+24y+20z = 4560$
$-4y-5z = -840$ (viii.)
Multiply (vii.) by 4 and (viii.) by 5, changing signs.
$20y+24z = 4080$
$20y+25z = 4200$
$z = \underline{120}$
Substitute this value of z in (viii.) changing signs.
$4y+600 = 840$
$4y = 240$
$y = \underline{60}$
Substitute these values of y and z in (iv.)
$6x+240+360 = 744$
$6x = 744-600$
$x = \underline{24}$

7. A geometrical progression is a series of quantities, each of which differs from its predecessor by a common ratio.
Thus let a represent the first quantity, and r the common ratio.
Then such a series is represented by a, ar, ar^2, ar^3, etc.—ar^{n-1}
To find the sum of n terms, if the first and second terms are given. We know the first, and by dividing the second by the first, we can find r, the common ratio.
The sum, $s = a+ar+ar^2+\text{etc.}+ar^{n-1}$
Multiply by r. $\therefore rs = ar+ar^2+ar^3+\text{etc.}+ar^n$
Subtracting, $rs-s = ar^n-a$
$s(r-1) = ar^n-a$
$$s = \frac{ar^n-a}{r-1} = \frac{a(r^n-1)}{r-1}$$
$a = 2$ in the case given.
$ar = 3$. $\therefore r = \frac{3}{2}$, and $n = 12$.
$$s = \frac{a(r^n-1)}{r-1} = \frac{2[(\frac{3}{2})^{12}-1]}{\frac{3}{2}-1} = \frac{\frac{3^{12}}{2^{11}}-2}{\frac{1}{2}}$$
$$= \frac{3^{12}}{2^{11}} \times \frac{2}{1} - 2 \times \frac{2}{1} = \frac{3^{12}}{2^{10}} - 4 = \frac{729^2}{64^2} - 4$$
$$= 729^2 - 4 \times 64^2 = (729+128)(729-128)$$
$$= 857 \times 601 = \underline{515057.}$$

8. The question is one in arithmetical progression. A series of quantities are in arithmetical progression when each of them differs from its predecessor by a common difference. Thus, let a represent the first quantity, and d the common difference; then the series is represented by
a, $a+d$, $a+2d$, $a+3d$, etc., $a+(n-1)d$.
Hence the sum of such a series
$= a+(a+d)+(a+2d)+\text{etc.}+[a+(n-1)d]$,
or, writing it in reverse order,
$= [a+(n-1)d]+[a+(n-2)d]+\text{etc.}+a$
$\therefore$ Adding these two equations,
$2s = [a+(n-1)d)+[a+(n-1)d]$ taken n times
$= [a+(n-1)d]n$
$$\therefore\ s = [a+(n-1)d]\frac{n}{2}$$
In the particular case given,
$s = [80+29\times30]15$
$= (80+870)15$
$= 950 \times 15 = 14250$
This + 1500, with which he started,
$= \underline{£15750.}$

9. $(1-x+x^2-x^3+x^4)^3$
$=1+x^2+x^4+\underline{x^6+x^8}\cdot\ 2x+2x^3-2x^3+2x^4-2x^5+2x^6$
$\underline{-2x^5-2x^7+2x^6-2x^7}$

All those quantities underlined cannot enter into the answer, as they are higher powers of x than x^4

$(1-2x+3x^2-4x^3+5x^4)\ (1-2x^2+4x^4)$

The only product of the first bracketful by 1 that enters into the answer is $5x^4$.

The only product of it by $-2x^2$ is $-6x^4$
" " " $4x^4$ is $4x^4$
$5-6+4=3$

10. With 310 men, breadth 11 ft., depth 6 ft., time $\frac{1}{2}$ hr., [length = 155
" 1 " " 1 " " 1 " " 1 "
$=\frac{155\times11\times6\times2}{310}$

With 2000 men, breadth 10 ft., depth 7 ft., time 6 hrs., length
$=\frac{\cancel{155}\times11\times6\times\cancel{2}\times2000\times6}{\cancel{310}\times10\times7}=\frac{792}{7}$
$=\underline{113\frac{1}{7}\text{ yards.}}$

Latin Translation.

A.

These things having taken place, leaving Labienus on the Continent, with three legions and two thousand cavalry, to protect the ports and look after a supply of corn, and ascertain what things were being done in Gaul, and take counsel according to time and circumstance, he himself, with five legions and an equal number of cavalry [to that], which he had left on the Continent, put to sea at set of sun, and, borne onwards by a light south-west wind, the wind falling about midnight he could not hold his course, and, carried too far by the tide, saw at dawn Britain lying behind [him], on his left. Then again following the turn of the tide, he strove, by rowing, to reach that part of the island where he had ascertained, in the preceding summer, the best landing place was. In which matter the courage of the soldiers was much to be praised, who, in transport and heavily-laden ships, without the intermission of the work of rowing, kept pace with the ships of war.

B.

This debate having been held on both sides, when a vigorous resistance was made by Cotta and the chief centurions, Sabinus said, and [said] it with so clear a voice that a great part of the soldiers could hear him: 'Gain the victory, if you so wish it. I am not one,' said he, 'who would be very terrified at the danger of death at your hand: these will know; if anything more dangerous happens they will require an account from you: they who, if you will [if it is permitted by you], uniting with the nearest winter quarters on the day after to-morrow, can bear the calamities of war in common with the rest, and not, forced away and banished far from the others perish by sword or famine.' They rise from the council; and *they* (their friends) take hold of them both and beg them not to lead things into [a position of] the greatest danger by their difference in opinion and obstinacy; that the affair was easy, whether they stay or depart, if only they all consent to and approve one thing; on the other hand, they see no safety in disunion.

C.

Whatever money the men have received from their wives in the name of a dowry, so much do they add from their own property to the dowry, a calculation having been made. An estimate of all this united money is kept, and the interest is laid by: whichever of the two survives the other, to that one the portion of both, with the interest of former times, falls. The men have the power of life and death over their wives just as over their children; and when a father of a family, born of high rank, dies, his relatives assemble, and if the affair of his death is suspicious [literally, comes into suspicion], they hold an examination, with the wives in the manner of slaves, and, if anything is found out, slay them, tortured with fire and all kinds of torments. The funerals are, for the manner of the Gauls, magnificent and costly; and all which they think the man, when living, had at heart, they set on fire, even animals: and a little before this generation [literally, memory] slaves and clients, whom it is certain had been beloved by the dead, were destroyed together, when the due funeral rites were completed.

II.—History and Geography.

N.B.—The map is not shown.

1. Cæsar sailed from Portus Itius (a port of the Morini, in Belgic Gaul, either Boulogne or Vissant, near Calais), with five legions. He landed in Kent, somewhere near the South Foreland or Dover. He advanced beyond the Thames, took and burnt Verulamium (St. Albans, in Hertfordshire), the fortress of Cassivelaunus, chief of the Trinobantes, and set up in the place of this chieftain Mandubratius. Then he returned to Gaul.

2. The Cassi were the people who inhabited the land on the north bank of the Thames, about Hertford and Bedford. The Eburones were north of the Remi, on the banks of the Mosa (Meuse), from Liège of to-day to Aix-la-Chapelle.

The Remi were a tribe of Belgic Gaul, who occupied the south-east of the Arduennian Forest, situated between the Rhine and the Seine, bordered on the north by the river Sabis and stretching south from Paris to Strasbourg. Their chief town was Durocortorum (Rheims).

The Carnutes occupied the present departments of Eure et Loire, Seine et Oise, and Loiret, dwelling on both sides of the Liger (Loire). Chief town, Autricum (Chartres).

The Treviri dwelt south of the Forest Arduenna, and west of the Rhine.

The Cherusci inhabited the present principality of Hanover.

The Trinobantes inhabited Essex and Middlesex.

The Meldi inhabited the department named Marne.

Leutetia (Paris) belonged to the tribe Parisii.

Agendicum (Sens, in Champagne; according to some, Provens) was a town of the Senones.

Noviodunum (now Soissons) belonged to the Suessones. Two other towns (Nouan and Nevers) are sometimes given as its modern equivalent.

Durocortorum (Rheims), the capital of the Remi.

3. The whole of the legion, under Cæsar, was armed and equipped alike, each man being furnished with the pilum, a heavy javelin. In battle-order the legion consisted of two lines, each of five cohorts, with a space between each pair of cohorts. The younger soldiers were placed behind, and the veterans in front. When operations required great activity, detachments of legionaries were lightly armed and marched without baggage.

The cavalry attached to the army were very few in number.

Cæsar had also with him the *Levis Armatura* (light-armed), consisting of foreign mercenaries possessing skill in the use of the national arms, such as the sling, bow, and dart.

The officers of the legion were called centurions. The foreign soldiers were divided and commanded according to the custom of their nation. The cavalry were no longer in his time Roman equites but foreigners. The equites were only employed as aides-de camp and confidential messengers. The distinction between the Roman legions and the Socii had vanished.

4. The time is at the outbreak of the second civil war between Pompey and Cæsar. The jealousy of the former had brought him into alliance with the aristocracy against Cæsar. He had obtained the renewal of the old law that no one should become a candidate for office while away from Rome. Cæsar was in Gaul, and was anxious to be a second time consul. The Senate had granted him the retention of his army in the Spains for five years longer, and Cæsar was to disband his. A law was passed enacting that no one should hold a province within five years of holding office. Consuls and one tribune were against Cæsar. A legion was, under a specious pretext, kept from him. He had written to the Senate that if Pompey would, he also would, resign his command. On the motion of Scipio, father-in-law of Pompey, Cæsar was to disband his army by a certain date or be an enemy of the State. Then Cæsar waiting at Ravenna for the decision, crossed the Rubicon, and marched towards Rome. The war had begun.

5. Cæsar, at the time when Book V. begins, had conquered the Belgæ, and crossed the Rhine into Germania, and had also visited Britain once (54 B.C.).

His power was unlimited, and obtained partly by conquest, partly by friendship. He induced the Tribune Vatinius to propose a bill to the people granting him the provinces of Cisalpine Gaul and Illyricum for five years (58-54). Cæsar chose the Gallic provinces, as he would thus be able to pass the winter in Italy.

Passages for translation from books not previously given.

III. (*a*). Anger told (prevailed) rather than pity in respect to these (people), because they were incensed not only as with foes, but as it were with a race untamed and incapable as allies. When they had fought through certain days, they were at last of

opinion that peace should be neither given nor denied. Two conditions were offered to them: either that they should grant the Senate arbitrament concerning them, or that they should pay 1,000 talents and hold the same people as friends and foes [as the Romans]. To them wishing to get out [of the Romans] things on which they were to grant the Senate [the right of] arbitrament in respect to themselves, nothing certain was answered.

(*b*) Lastly, let our necessity be blamed that on all sides are cares, and there will be no one who will undertake the work. If strength is wanting, nevertheless the will is to be praised. I think the gods are content with this. These things he does that he may come to the altars as a man well-beloved, and also that the lamb [of sacrifice] may, not less than the slain ox, be well pleasing.

English History and Modern Geography.

1. The four chief traces. (1) The remains of the two walls built across the country in the north of England. Of these the south one ran from the mouth of the Tyne to the Solway Firth on the west. This line of forts was known as the Wall of Hadrian, and was the northern boundary of the Roman division of Britain known as Flavia Cæsariensis, the southern of the division Valentia. The northern wall ran from the Firth of Forth on the east to that of Clyde on the west. This was the wall of Agricola, lieutenant of Vespasian, known later as that of Antonine (successor of Hadrian), and to-day as Graham's Dyke. This northern wall bounded Valentia on the north, and Vespasiana, or Caledonia, on the south. The object of both lines of forts was the warding off attacks from the Celts of the region now known as Scotland.

(2) The roads. The four chief ones of which the remains are still to be seen were: (*a*) Watling Street (stratum), from Rutupiæ (Richborough) in Kent, through London to Carnarvon; (*b*) Ikenild Street, from Tynemouth, through York, Derby, and Birmingham to St. David's, in Pembroke; (*c*) Irmin Street, from St. David's to Southampton; (*d*) Foss Way, from Lincoln to Cornwall.

(3) The names of certain places are wholly or partly derived from the Latin. Chester, Doncaster, etc., are from *castra*, a camp; Lincoln is from *colonia*, a colony.

(4) The language, as a whole, has been influenced by the Romans of the invasion of Cæsar, and the subsequent military rule. Many terms of warfare came in, such as arms, castle. With the introduction of Christianity by the Romans (after the Celts had long known of the new creed), came in ecclesiastical words, such as minster, candle.

(5) Buildings and baths are found as monuments in certain parts of England, either on the surface or just beneath the soil, and remains of Roman camps are not infrequent.

2. Northumbria was originally one of the seven divisions of the Saxon Heptarchy, lying northward of the Humber and the Dee, and reaching to the Forth, in Scotland. It was one of the last of the seven to survive ere all were merged in one kingdom. Under Eadwine it was at its strongest. Then it not only extended to the Forth, but all of England south of the Humber, save Kent, owned Eadwine as Lord. To the west it reached Chester, and, by sea armaments, the isles of Anglesea and Man.

Mercia was the midland division of the Heptarchy, a kind of rough square with, for four corners, the mouths of the Humber, Thames, Severn, and Dee, subject when Northumbria was at its best to Northumbria; later on Mercia became a great power. Under Wulfhere not only mid-England came back to him, but Essex, London, Sussex, and part of Wessex, with the Isle of Wight, were Mercian territory. A little later, under Ethelbald, all of England south of the Humber was Mercian. Under Offa, even Northumbria was subservient to this powerful kingdom. After the death of Offa, the strength of Mercia declined. Beornwulf, however, invaded Wessex, with intent to break up the power of Egbert. But the victory of the latter gave to Wessex the two kingdoms of Kent and Sussex, until then Mercian. Then East Anglia revolted from Mercia to Wessex, and soon Northumbria gave in allegiance to Egbert. East Anglia, Mercia, Northumbria were thenceforward tributary to Wessex, appointing kings subject to the king of Wessex.

3. Christianity was the religion of the Celts long before the Teutons of England adopted it. But anything like a general acceptance of it in England did not occur till after the visit of Augustine. Pope Gregory, of whom is told the story of the meeting with the Saxon slaves in the market-place at Rome, sent forty missionaries, with Augustine at their head. These landed in Kent. Kent's king, Ethelbert, had for wife a Christian princess, Bertha of Paris. Hence the Roman monks had a resting-place given them in the Isle of Thanet, and a conference was held. As a result of this, Ethelbert and many of his subjects were baptised. Augustine was made the first Archbishop of Canterbury, and founded the see of Rochester. Ethelbert's nephew, Sebert, King of Essex, was next converted by Mellitus, afterwards created first bishop of London. St. Paul's was built where a temple to Diana had stood, and St. Peter's near where Westminster Abbey now is. Edwin of Northumbria, whose wife was a daughter of Edred, was a convert of Paulinus. His baptism took place where York minster now stands.

In the ninth contury the clergy were, as the only educated people, of great power in England. Their power is seen at its greatest height in the person of Dunstan, Abbot of Glastonbury, ruler of the nominal ruler, Edred. Edwy, the successor of Edred, made Dunstan Archbishop of Canterbury, and in all ways favoured the monks. The Benedictines were the chief monastic corporation of the century in England, and Dunstan was of them. They enforced the celibacy of the clergy.

4. The most intimate connexion between England and the Continent before the year 900 was by way of war. The Danes were constantly harrying the eastern coast, leaving traces of their fierce attacks wherever they landed, in the form of burnt villages and slaughtered men and women. To-day many names on the eastern shores, or in the midlands, are Scandinavian—Whitby, Derby. Names of people ending in *ulph* (wolf), the words *force* (waterfall), *ravine*, *arr*, are all Danish.

The religious connexion with Rome was kept up. Peter's pence were contributed to the support of Romish ceremonial. Pilgrimages were made to Rome, as by Ini of Wessex. Journeys also were made thither, as by the young Alfred.

Continental scholars were invited to England, especially by Alfred, and the chief works he translated, Boethius' 'Consolations of Philosophy,' Orosius' 'Universal History,' Pope Gregory's 'Pastoral,' show, how as yet, England was mainly dependent for her literature on foreign peoples.

5. In the Anglo-Saxon constitution the chieftain (heretoga, or army-leader) became the cyning, or king (the kenning, or knowing, man, say some). The office was elective, but was generally retained in one family, though it did not necessarily pass directly from father to son.

Originally each king of each division of the Heptarchy had been known, and even personally known, to his people. But as the seven kingdoms merged into one, the king faded further and further from the sight of his subjects. He became a mystery, and as one gifted with an almost superhuman dignity. This was all favoured by religion. For now he was the anointed of the Lord, and treason against him was a capital crime. In the early time a bishop was equal in life-value to a king. At the end of the Saxon time and after, he was only the equal of the ealdorman.

Freedom gave place to villenage. The feudal system held sway. The king was absolute over-lord of all. All were directly or indirectly bound to do him service. The ealdormen, once hereditary rulers of small states, are under the Normans only tenants-in-chief of the king. Those that had been the king's comrades, forming his war-band, now his servants. The common-land has become folc-land, is in the hands of the monarch, and is carved out into estates for his followers.

With all this begins a limitation of the kingly power in a new direction. The Church that had helped to make the monarchy what it was in absolute irresponsibility, now begins to oppose the power that it had in large measure created.

6. (1) Lanfranc, of Pavia, in Lombardy by birth, teacher at Avranches, monk and teacher at Bec, had crossed swords with William when the latter was only Duke of Normandy, in the matter of his marriage with Matilda of Flanders. When William of Normandy became William I. of England, he sent for Lanfranc, and made him Archbishop of Canterbury. This was with a view to enlisting Lanfranc's services and those of his Church against the feudal nobles in the triangular duel between Crown, clergy, and baronage. Between William and Lanfranc began the struggle of Crown and Church for supremacy.

(2) Anselm, of Aosta, pupil and successor of Lanfranc at Bec, was also his successor in the see of Canterbury, after a long time of vacancy in the see, during which the king (William I.) received its revenues. The contest here turned chiefly on points that are not intrinsically of moment now. But the principle of resistance to, and conflict with, the king was established by Anselm.

(3) Becket. Here the struggle is of a more vital nature. Matters had grown to a head. In the persons of Becket, the first English Archbishop of Canterbury, and Henry II., one of

the ablest of the Norman kings, two nationalities, as well as two orders, were contending. The power of the clergy was at its height. Offenders among the clergy were tried by their own body, as if they were a race of men apart. On this particular point the general quarrel broke out. By the Constitutions of Clarendon this privilege was done away with: the king was the keeper of vacant benefices and their revenues; appointments to these benefices must have his approval.

(4) Langton. Here the contest is more national in character than in any of the preceding cases. Not in its first phases. The difficulty as to the appointment of an Archbishop of Canterbury, John's choice of De Grey, Bishop of Norwich, the monks' choice of Reginald, sub-prior, Pope Innocent III.'s of Langton, John's expulsion of the Christ Church monks, Innocent's interdict and excommunication, his command to Philip of France that he depose John, the submission of the latter, are events in the fight for mastery between English kings and the Holy See. But the later and nobler struggle in which Langton, with his discovery of the charter of Henry I., his convening an assembly at St. Edmundsbury, his encouragement and guidance of the barons, his share in the framing of Magna Charta and in the compelling of John to sign it, played so great a part—this was a contest of a large part of a nation against a king.

(7) In the time of Henry III., the prevailing discontent found a voice and a leader in Simon de Montfort, Earl of Leicester. Calling together the chief barons in secret, he engaged them in a confederacy to take into their hands the government. When next Henry met his Parliament, at Oxford, the barons came armed. Henry had to promise to call together a Parliament to settle the affairs of the realm. This Parliament, the Mad, appointed fifteen men, who drew up the Provisions of Oxford, of which the chief were that four knights should be chosen as spokesmen of each county and tellers of its grievances, and that Parliament should meet thrice a year. After the civil war had broken out, and the battle of Lewes had been fought, De Montfort summoned a Parliament in London. To this, nobles, prelates, *and* two knights from each shire, two burgesses from each city and borough, were called. In these two last was the germ of the House of Commons.

8. Edward III. claimed the French crown by virtue of his descent, through his mother, from Philip III., whose son, Philip IV., was his grandfather. None of the sons of Philip IV. had male issue; Isabella, the daughter, had, in the person of Edward III. But a brother of Philip IV., Charles of Valois, was father of a son who ruled France as Philip VI. Through male ancestry Edward had no claim, and, if he claimed the crown through a woman (his mother), Charles of Navarre, grandson of Louis X., eldest son of Philip IV., had a better right.

Edward crossed to Flanders, and invaded France. Then, a year later, he won a sea-fight at Sluys, challenged Philip to single combat, made a two years' truce. After this, landing at Cape la Hogue, he marched nearly to Paris, retreated towards Flanders, fought, in the person of his son Edward the Black Prince and of his soldiers, the battle of Crecy, besieged and took Calais, made another truce with France, then invaded that country from Calais. His son, a little later, invaded France from the south, and, returning to Guienne, won the battle of Poictiers. A two years' truce, the taking to London of John, King of Bohemia, his treaty, and the French refusal to ratify it, a new invasion, and the treaty of Bretigny end the struggle. By that treaty, Edward resigned all claim to the crown of France, to Normandy, Maine, Touraine, Anjou; retained Poitou, Guienne, and other southern provinces, free of homage to France; released John.

9. 1st St. Albans, Northampton, Wakefield, Mortimer's Cross, 2nd St. Albans, Towton, Hedgley Moor, Barnet, Tewkesbury, Bosworth. All but Wakefield, second St. Albans, and Bosworth were won by the Yorkists.

The chief results of these wars were the settlement of the Tudor family on the throne, the growing authority of the Crown, the relative weakness in numbers and power of the nobles, the increasing wealth and importance of the middle class, and the commencement of the existence of an unemployed, wageless class, the reserve army of labour.

10. *Morton*, when bishop of Ely, devised the plan for uniting the rival houses of York and Lancaster, by marrying Henry of Richmond and Elizabeth of York, eldest daughter of Edward IV.

Thomas Cromwell, servant of Wolsey, his defender in the House of Commons, and successor in power, Secretary of State, supporter of the Reformation, vicar-general or vice-regent in things ecclesiastical, suppressor of the monasteries, planner of the marriage between Henry VIII. and Ann of Cleves; arrested and executed for heresy and treason.

Earl of Essex, leader of the expedition against Spain, favourite of Elizabeth, patron of Francis Bacon, Lord-Lieutenant of Ireland; returns unbidden to England; plotter against Elizabeth, and for James of Scotland as king, futile insurrectionist in the streets of London; arraigned; beheaded.

Lady Jane Grey, daughter of the Duke of Suffolk, granddaughter of Mary Tudor, Queen of France; pupil of Roger Ascham; wife of Guildford Dudley, son of the Duke of Northumberland; proclaimed queen; arrested; tried; beheaded.

Archbishop Cranmer, of Cambridge; suggests appeal to European universities in the matter of Henry VIII.'s difficulty as to his wife Catherine of Arragon; primate; annuls the Catherine marriage; a little later, annuls that with Anne Boleyn; opposes the Statute of the Six Articles, but dismisses, in accordance with them, his own wife; is at Henry's death-bed; one of the executors appointed by Henry to act during Edward VI.'s minority; helps in the publications of the English Church (prayer-book, articles, Bible, homilies); committed to the Tower under Mary; condemned; recants; is yet to die; re-recants; dies bravely.

Cardinal Pole, connected with the Royal Family through Margaret, Countess of Salisbury, daughter of the Duke of Clarence; brother of Edward IV.; attacks Henry VIII. for the suppression of the monasteries; attainted; attainder reversed under Mary; papal legate; helps to reconcile England to Rome; archbishop of Canterbury.

Lord Burleigh, adviser of Elizabeth, as Sir Robert Cecil, and later, as Lord Burleigh, in all her difficult negotiations with Mary of Scotland and Philip of Spain; in him she had most confidence; a Catholic, and yet anxious for the Protestant succession.

11. The death of Buckingham (1628) at the hands of Felton, removed an able ally from the king's side. Wentworth was gained over to that side. The Parliament (January, 1629) refused supply until they had discussed grievances. Their resolution, directed against the king, was put and carried whilst the Speaker was held down in the chair. The king dissolved this Parliament. Eliot, Hollis, and Valentine were imprisoned, and Eliot died. Then followed the eleven years' (1629-1640) tyranny of Charles, Henrietta Maria, Laud, Wentworth. The High Commission (ecclesiastical) and Star Chamber (civil) courts fined and imprisoned. Laud was turning the English Church towards Rome; Wentworth was maturing his plan "Thorough," trying the experiment of absolute rule in Ireland. Then (1637) came the trial and condemnation of John Hampden for refusing to pay the illegal tax of ship-money. The attempt to force on Scotland a liturgy (1637) brought things to a crisis. The "Tables," a provisional government of nobles, gentlemen, ministers, burgesses, drew up the Covenant (1638), and Scotland prepared for war. Charles raised an army, marched north (1639), and yielded everything. A general assembly should and did meet. Such proposals were made that it was prorogued. It continued to sit, and war broke out again. This necessitated the calling of an English Parliament. This was the short one (1640). Down march the Scots, cross the Tweed, take Newcastle. Charles goes to York, and calls a council of the peers. A treaty, appointment of commissioners, an armistice, the removal of negotiations to London, and a weekly subsidy of £5,600 to the Scots as long as they are in England, are all agreed upon; a new Parliament is called, and all the popular leaders are returned. This is the Long Parliament (1640). Petitions for redress of grievances poured in; Strafford was impeached and executed (1641); delinquents (those that had concurred in any of the two courts' sentences) were proceeded against. The Triennial Act (that a Parliament meet at least once in three years) was passed. The courts were abolished, the armies disbanded, tonnage and poundage granted for less than two months to the king; the committee on scandalous ministers inquired into the personal conduct of the clergy. An Irish rebellion broke out (1641); Parliament, reassembling, drew up the Remonstrance, enumerating the grievances of sixteen years. Conflicts began in London streets between the two parties, now beginning to be known as Roundheads and Cavaliers. The Five Members were impeached in 1642—Pym, Hampden, Haselrig, Hollis, Strode. The king came down to the House to arrest them. With that, to all intents and purposes, the Civil War began.

12. For the provinces of India see any atlas of modern geography.

The following are the British Provinces and Presidencies:—

		CAPITAL.	OTHER TOWNS.	RIVERS.
1	Bengal	Calcutta	Patna, Dacca	Ganges
2	North-west Provinces; including Oude	Allahabad Lucknow	Benares, Agra Fyzabad	Jumna
3	The Punjaub	Lahore	Delhi	Indus
4	Central Provinces	Nagpore	Kamptee	Godavery
5	Mysore, Berar, and Coorg	Mysore	Bangalore	Payne Gunga
6	Assam	Gowhatty	Sibsagar	Brahmapootra
7	British Burmah	Rangoon	Pegu	Irawady
8	Madras	Madras	Arcot	Cauvery
9	Bombay, with Scinde	Bombay	Surat	Beema

13. The oldest possessions of England are the Channel Islands, which belonged to William, Duke of Normandy, and became possessions of England when William became King of England, 1066.

Ireland was annexed to England in 1172, in the reign of Henry II.

All the other possessions have been acquired later; the possessions in America from 1609 to 1858. The possessions in Oceania are still later acquisitions, from 1788 to 1874.

14. It has already been shown how the Channel Islands were acquired.

Gibraltar was conquered from Spain in 1704. Malta was capitulated by France in 1800. Jamaica capitulated 1655.

Orkney came at the union with Scotland, 1603.

15. Tewkesbury, in Gloucestershire, on the Severn, about ten miles up the river from Gloucester, is noted for the battle which took place there between the Lancastrians and Yorkists (1471).

Dunbar is situated on the coast of Haddington, in Scotland. Here Baliol was completely defeated by Edward I., 1296. Another battle was fought here in 1650, in which Cromwell defeated the Scots.

Prestonpans in Haddingtonshire, about 12 miles east of Edinburgh, is noted for the battle which Charles Edward won over Cope, 1745.

The Boyne, a river in Ireland, running into St. George's Channel. William III. here defeated James II., 1690.

St. Albans, in Hertfordshire, is about 20 miles north of London. It is noted for two battles—first in 1455, when the Yorkists defeated the Lancastrians; second, in 1461, when Margaret defeated the Yorkists.

Marston Moor, near York. Cromwell gained a great victory here in 1644.

Torbay, on the coast of Devon, is noted as the landing-place of William and Mary.

Pevensey, in Sussex, is noted as the landing-place of William, Duke of Normandy.

Battle Abbey, near Hastings: an abbey erected by William I., who enjoined the monks to pray for the soul of Harold.

Edgehill, in Warwickshire. An undecisive battle between Charles and the Parliamentarians took place here, 1642.

Greek.

I. XENOPHON: HELLENICS II.

A.

But the Athenians, besieged by land and by sea, were at a loss (as to) what ought to be done, as neither ships, allies, nor corn were theirs; they thought that there was nothing to save them from suffering that which they had done to others without provocation, when, in wantonness, they had wronged men of small states, and for no other reason than they had fought on the side of the Lacedæmonians [literally, those]. For these reasons they made those that had been deprived of their privileges citizens [again], and held out; and, though many were dying of hunger in the city, they said nothing about coming to terms. But when now their corn had altogether given out, they sent ambassadors to Agis, wishing to be allies of the Lacedæmonians while they retained their walls and the Piræus, and [willing] on these conditions that a treaty should be made.

B.

Now, the thirty were chosen as soon as over the long walls and those around the Piræus had been destroyed, but, though chosen for this, to draw up laws by which the people might be governed, they ever deferred drawing up and publishing them, and [instead of this] appointed a council and other officers as they pleased. Then, first, they arrested and tried for their lives all those whom they knew to have lived in the democracy as informers, and to have been a danger to the honest and good; and both the council gladly sentenced these, and the rest [of the people], those that knew they were not such as these, were by no means displeased. But when they began to take counsel how it might be possible for them to do as they would in the city [literally, to use the city as they liked], upon their first sending to Lacedæmon Æschines and Aristoteles, they persuaded Lysander to arrange that a guard should come to them until they had put the ill-disposed out of the way, and established the government; they promised to maintain [the guard].

C.

He spoke thus: But the rest of the commanders, [and the more] because they had heard such a speech, led back the men with them to the city. On the following day, the thirty, all solitary and cast down, sat together in the council, and of the 30,000, wherever any were posted, they were everywhere at variance with one another. For such as had acted more violently, and were afraid, said strongly that they ought not to submit to the men in the Piræus, and such as knew they had done no wrong, both thought themselves and told the others that none of these ills would happen, and they denied that they ought to obey the thirty and allow them to ruin the State. And at length they voted for deposing them and choosing others, and they chose ten, one from each tribe.

II. GRAMMAR.

1. ἠπόρουν. Neuter, indicative, imperfect, plural, 3rd person, from ἀπορεω.

πάθειν. Neuter, infinitive, aorist 2, from πασχω.

ἐπελελοίπει. Active, indicative, pluperfect, singular, 3rd person, from ἐπιλείπω.

ἠρέθησαν. Passive, aorist 1, plural, 3rd person, from αἱρεω.

κατέστησαν. Active, indicative, aorist 1, plural, 3rd person, from καθίστημι.

ᾔδεσαν. Active, indicative, pluperfect, plural, 3rd person, from οἶδα (perfect form for εἰδω).

απήγαγον. Middle, indicative, imperfect, plural, 3rd person, from ἀφηγεομαι.

τεταγμένοι. Passive, participle, perfect, singular, masculine nominative, from τάσσω.

2.

	Singular.		*Plural.*	
N.	ἀνηρ	εὐσεβὴς	ἀνδρές	εὐσεβεῖς
V.	ἄνερ	εὐσεβὴς	,,	,,
Ac.	ἄνδρα	εὐσεβῆ	ἀνδράς	εὐσεβεῖς
G.	ἀνδρός	εὐσεβοῦς	ἀνδρῶν	εὐσεβῶν
D.	ἀνδρί	εὐσεβεῖ	ἀνδράσι	εὐσεβέσι

Dual.

N. V. A. ἀνδρε

G. D. ἀνδροῖν

	Singular.		*Plural.*	
N.	καλλίων	γυνή	καλλίονες	γυναῖκες
V.	καλλίων	γύναι	,,	,,
A.	καλλίονα	γυναῖκα	καλλίονας	γυναῖκας
G.	καλλίονος	γυναικός	καλλιόνων	γυναικῶν
D.	καλλίονι	γυναικί	καλλίοσι	γυναιξί

Dual.

N. V. A. καλλίονε γυναῖκε

G. D. καλλίοιν γυναικοῖν.

	Singular.		*Plural.*	
N.	μέλαινα	θριξ	μέλαιναι	τρίχες
V.	,,	,,	,,	,,
A.	μέλαιναν	τρίχα	μέλαινας	τρίχας
G.	μελαίνης	τρίχος	μελαινῶν	τριχων
D.	μελαίνῃ	τρίχι	μέλαίναις	θριξι

Dual.

N. A. V. μελαίνᾶ τρίχε

G. D. μελαίναιν τρίχοιν.

(*Concluded on page* 312).

German.

A.

Louis 18th did not in the slightest degree present the appearance of that strong and determined personality one seeks upon a throne. Upon him nothing of the winning and taking disposition of his father, nor of the love of pomp (luxury) of his mother, had descended. About him was neither show nor comfort; his ante-rooms were empty of the nobility of the court that usually

the ablest of the Norman kings, two nationalities, as well as two orders, were contending. The power of the clergy was at its height. Offenders among the clergy were tried by their own body, as if they were a race of men apart. On this particular point the general quarrel broke out. By the Constitutions of Clarendon this privilege was done away with: the king was the keeper of vacant benefices and their revenues; appointments to these benefices must have his approval.

(4) Langton. Here the contest is more national in character than in any of the preceding cases. Not in its first phases. The difficulty as to the appointment of an Archbishop of Canterbury, John's choice of De Grey, Bishop of Norwich, the monks' choice of Reginald, sub-prior, Pope Innocent III.'s of Langton, John's expulsion of the Christ Church monks, Innocent's interdict and excommunication, his command to Philip of France that he depose John, the submission of the latter, are events in the fight for mastery between English kings and the Holy See. But the later and nobler struggle in which Langton, with his discovery of the charter of Henry I., his convening an assembly at St. Edmundsbury, his encouragement and guidance of the barons, his share in the framing of Magna Charta and in the compelling of John to sign it, played so great a part—this was a contest of a large part of a nation against a king.

(7) In the time of Henry III., the prevailing discontent found a voice and a leader in Simon de Montfort, Earl of Leicester. Calling together the chief barons in secret, he engaged them in a confederacy to take into their hands the government. When next Henry met his Parliament, at Oxford, the barons came armed. Henry had to promise to call together a Parliament to settle the affairs of the realm. This Parliament, the Mad, appointed fifteen men, who drew up the Provisions of Oxford, of which the chief were that four knights should be chosen as spokesmen of each county and tellers of its grievances, and that Parliament should meet thrice a year. After the civil war had broken out, and the battle of Lewes had been fought, De Montfort summoned a Parliament in London. To this, nobles, prelates, *and* two knights from each shire, two burgesses from each city and borough, were called. In these two last was the germ of the House of Commons.

8. Edward III. claimed the French crown by virtue of his descent, through his mother, from Philip III., whose son, Philip IV., was his grandfather. None of the sons of Philip IV. had male issue; Isabella, the daughter, had, in the person of Edward III. But a brother of Philip IV., Charles of Valois, was father of a son who ruled France as Philip VI. Through male ancestry Edward had no claim, and, if he claimed the crown through a woman (his mother), Charles of Navarre, grandson of Louis X., eldest son of Philip IV., had a better right.

Edward crossed to Flanders, and invaded France. Then, a year later, he won a sea-fight at Sluys, challenged Philip to single combat, made a two years' truce. After this, landing at Cape la Hogue, he marched nearly to Paris, retreated towards Flanders, fought, in the person of his son Edward the Black Prince and of his soldiers, the battle of Crecy, besieged and took Calais, made another truce with France, then invaded that country from Calais. His son, a little later, invaded France from the south, and, returning to Guienne, won the battle of Poictiers. A two years' truce, the taking to London of John, King of Bohemia, his treaty, and the French refusal to ratify it, a new invasion, and the treaty of Bretigny end the struggle. By that treaty, Edward resigned all claim to the crown of France, to Normandy, Maine, Touraine, Anjou; retained Poitou, Guienne, and other southern provinces, free of homage to France; released John.

9. 1st St. Albans, Northampton, Wakefield, Mortimer's Cross, 2nd St. Albans, Towton, Hedgley Moor, Barnet, Tewkesbury, Bosworth. All but Wakefield, second St. Albans, and Bosworth were won by the Yorkists.

The chief results of these wars were the settlement of the Tudor family on the throne, the growing authority of the Crown, the relative weakness in numbers and power of the nobles, the increasing wealth and importance of the middle class, and the commencement of the existence of an unemployed, wageless class, the reserve army of labour.

10. *Morton*, when bishop of Ely, devised the plan for uniting the rival houses of York and Lancaster, by marrying Henry of Richmond and Elizabeth of York, eldest daughter of Edward IV.

Thomas Cromwell, servant of Wolsey, his defender in the House of Commons, and successor in power, Secretary of State, supporter of the Reformation, vicar-general or vice-regent in things ecclesiastical, suppressor of the monasteries, planner of the marriage between Henry VIII. and Ann of Cleves; arrested and executed for heresy and treason.

Earl of Essex, leader of the expedition against Spain, favourite of Elizabeth, patron of Francis Bacon, Lord-Lieutenant of Ireland; returns unbidden to England; plotter against Elizabeth, and for James of Scotland as king, futile insurrectionist in the streets of London; arraigned; beheaded.

Lady Jane Grey, daughter of the Duke of Suffolk, granddaughter of Mary Tudor, Queen of France; pupil of Roger Ascham; wife of Guildford Dudley, son of the Duke of Northumberland; proclaimed queen; arrested; tried; beheaded.

Archbishop Cranmer, of Cambridge; suggests appeal to European universities in the matter of Henry VIII.'s difficulty as to his wife Catherine of Arragon; primate; annuls the Catherine marriage; a little later, annuls that with Anne Boleyn; opposes the Statute of the Six Articles, but dismisses, in accordance with them, his own wife; is at Henry's death-bed; one of the executors appointed by Henry to act during Edward VI.'s minority; helps in the publications of the English Church (prayer-book, articles, Bible, homilies); committed to the Tower under Mary; condemned; recants; is yet to die; re-recants; dies bravely.

Cardinal Pole, connected with the Royal Family through Margaret, Countess of Salisbury, daughter of the Duke of Clarence; brother of Edward IV.; attacks Henry VIII. for the suppression of the monasteries; attainted; attainder reversed under Mary; papal legate; helps to reconcile England to Rome; archbishop of Canterbury.

Lord Burleigh, adviser of Elizabeth, as Sir Robert Cecil, and later, as Lord Burleigh, in all her difficult negotiations with Mary of Scotland and Philip of Spain; in him she had most confidence; a Catholic, and yet anxious for the Protestant succession.

11. The death of Buckingham (1628) at the hands of Felton, removed an able ally from the king's side. Wentworth was gained over to that side. The Parliament (January, 1629) refused supply until they had discussed grievances. Their resolution, directed against the king, was put and carried whilst the Speaker was held down in the chair. The king dissolved this Parliament. Eliot, Hollis, and Valentine were imprisoned, and Eliot died. Then followed the eleven years' (1629-1640) tyranny of Charles, Henrietta Maria, Laud, Wentworth. The High Commission (ecclesiastical) and Star Chamber (civil) courts fined and imprisoned. Laud was turning the English Church towards Rome; Wentworth was maturing his plan "Thorough," trying the experiment of absolute rule in Ireland. Then (1637) came the trial and condemnation of John Hampden for refusing to pay the illegal tax of ship-money. The attempt to force on Scotland a liturgy (1637) brought things to a crisis. The "Tables," a provisional government of nobles, gentlemen, ministers, burgesses, drew up the Covenant (1638), and Scotland prepared for war. Charles raised an army, marched north (1639), and yielded everything. A general assembly should and did meet. Such proposals were made that it was prorogued. It continued to sit, and war broke out again. This necessitated the calling of an English Parliament. This was the short one (1640). Down march the Scots, cross the Tweed, take Newcastle. Charles goes to York, and calls a council of the peers. A treaty, appointment of commissioners, an armistice, the removal of negotiations to London, and a weekly subsidy of £5,600 to the Scots as long as they are in England, are all agreed upon; a new Parliament is called, and all the popular leaders are returned. This is the Long Parliament (1640). Petitions for redress of grievances poured in; Strafford was impeached and executed (1641); delinquents (those that had concurred in any of the two courts' sentences) were proceeded against. The Triennial Act (that a Parliament meet at least once in three years) was passed. The courts were abolished, the armies disbanded, tonnage and poundage granted for less than two months to the king; the committee on scandalous ministers inquired into the personal conduct of the clergy. An Irish rebellion broke out (1641); Parliament, reassembling, drew up the Remonstrance, enumerating the grievances of sixteen years. Conflicts began in London streets between the two parties, now beginning to be known as Roundheads and Cavaliers. The Five Members were impeached in 1642—Pym, Hampden, Haselrig, Hollis, Strode. The king came down to the House to arrest them. With that, to all intents and purposes, the Civil War began.

12. For the provinces of India see any atlas of modern geography.

The following are the British Provinces and Presidencies:—

		CAPITAL.	OTHER TOWNS.	RIVERS.
1	Bengal	Calcutta	Patna, Dacca	Ganges
2	North-west Provinces; including Oude	Allahabad Lucknow	Benares, Agra Fyzabad	Jumna
3	The Punjaub	Lahore	Delhi	Indus
4	Central Provinces	Nagpore	Kamptee	Godavery
5	Mysore, Berar, and Coorg	Mysore	Bangalore	Payne Gunga
6	Assam	Gowhatty	Sibsagar	Brahmapootra
7	British Burmah	Rangoon	Pegu	Irawady
8	Madras	Madras	Arcot	Cauvery
9	Bombay, with Scinde	Bombay	Surat	Beema

13. The oldest possessions of England are the Channel Islands, which belonged to William, Duke of Normandy, and became possessions of England when William became King of England, 1066.

Ireland was annexed to England in 1172, in the reign of Henry II.

All the other possessions have been acquired later; the possessions in America from 1609 to 1858. The possessions in Oceania are still later acquisitions, from 1788 to 1874.

14. It has already been shown how the Channel Islands were acquired.

Gibraltar was conquered from Spain in 1704. Malta was capitulated by France in 1800. Jamaica capitulated 1655.

Orkney came at the union with Scotland, 1603.

15. Tewkesbury, in Gloucestershire, on the Severn, about ten miles up the river from Gloucester, is noted for the battle which took place there between the Lancastrians and Yorkists (1471).

Dunbar is situated on the coast of Haddington, in Scotland. Here Baliol was completely defeated by Edward I., 1296. Another battle was fought here in 1650, in which Cromwell defeated the Scots.

Prestonpans in Haddingtonshire, about 12 miles east of Edinburgh, is noted for the battle which Charles Edward won over Cope, 1745.

The Boyne, a river in Ireland, running into St. George's Channel. William III. here defeated James II., 1690.

St. Albans, in Hertfordshire, is about 20 miles north of London. It is noted for two battles—first in 1455, when the Yorkists defeated the Lancastrians; second, in 1461, when Margaret defeated the Yorkists.

Marston Moor, near York. Cromwell gained a great victory here in 1644.

Torbay, on the coast of Devon, is noted as the landing-place of William and Mary.

Pevensey, in Sussex, is noted as the landing-place of William, Duke of Normandy.

Battle Abbey, near Hastings: an abbey erected by William I., who enjoined the monks to pray for the soul of Harold.

Edgehill, in Warwickshire. An undecisive battle between Charles and the Parliamentarians took place here, 1642.

Greek.

I. XENOPHON: HELLENICS II.

A.

But the Athenians, besieged by land and by sea, were at a loss (as to) what ought to be done, as neither ships, allies, nor corn were theirs; they thought that there was nothing to save them from suffering that which they had done to others without provocation, when, in wantonness, they had wronged men of small states, and for no other reason than they had fought on the side of the Lacedæmonians [literally, those]. For these reasons they made those that had been deprived of their privileges citizens [again], and held out; and, though many were dying of hunger in the city, they said nothing about coming to terms. But when now their corn had altogether given out, they sent ambassadors to Agis, wishing to be allies of the Lacedæmonians while they retained their walls and the Piræus, and [willing] on these conditions that a treaty should be made.

B.

Now, the thirty were chosen as soon as ever the long walls and those around the Piræus had been destroyed, but, though chosen for this, to draw up laws by which the people might be governed, they ever deferred drawing up and publishing them, and [instead of this] appointed a council and other officers as they pleased. Then, first, they arrested and tried for their lives all those whom they knew to have lived in the democracy as informers, and to have been a danger to the honest and good; and both the council gladly sentenced these, and the rest [of the people], those that knew they were not such as these, were by no means displeased. But when they began to take counsel how it might be possible for them to do as they would in the city [literally, to use the city as they liked], upon their first sending to Lacedæmon Æschines and Aristoteles, they persuaded Lysander to arrange that a guard should come to them until they had put the ill-disposed out of the way, and established the government; they promised to maintain [the guard].

C.

He spoke thus: But the rest of the commanders, [and the more] because they had heard such a speech, led back the men with them to the city. On the following day, the thirty, all solitary and cast down, sat together in the council, and of the 30,000, wherever any were posted, they were everywhere at variance with one another. For such as had acted more violently, and were afraid, said strongly that they ought not to submit to the men in the Piræus, and such as knew they had done no wrong, both thought themselves and told the others that none of these ills would happen, and they denied that they ought to obey the thirty and allow them to ruin the State. And at length they voted for deposing them and choosing others, and they chose ten, one from each tribe.

II. GRAMMAR.

1. ἠπόρουν. Neuter, indicative, imperfect, plural, 3rd person, from ἀπορεω.

πάθειν. Neuter, infinitive, aorist 2, from πασχω.

ἐπελελοίπει. Active, indicative, pluperfect, singular, 3rd person, from ἐπιλείπω.

ἠρέθησαν. Passive, aorist 1, plural, 3rd person, from αἱρεω.

κατέστησαν. Active, indicative, aorist 1, plural, 3rd person, from καθίστημι.

ᾔδεσαν. Active, indicative, pluperfect, plural, 3rd person, from οἶδα (perfect form for εἰδω).

απήγαγον. Middle, indicative, imperfect, plural, 3rd person, from ἀφηγεομαι.

τεταγμένος. Passive, participle, perfect, singular, masculine nominative, from τάσσω.

	Singular.		*Plural.*	
2. N.	ἀνηρ	εὐσεβής	ἀνδρές	εὐσεβεῖς
V.	ἄνερ	εὐσεβής	,,	,,
Ac.	ἄνδρα	εὐσεβῆ	ἀνδράς	εὐσεβεῖς
G.	ἀνδρός	εὐσεβοῦς	ἀνδρῶν	εὐσεβῶν
D.	ἀνδρί	εὐσεβεῖ	ἀνδράσι	εὐσεβέσι

Dual.

N. V. A. ἄνδρε

G. D. ἀνδροῖν

	Singular.		*Plural.*	
N.	καλλίων	γυνή	καλλίονες	γυναῖκες
V.	καλλίων	γύναι	,,	,,
A.	καλλίονα	γυναῖκα	καλλίονας	γυναῖκας
G.	καλλίονος	γυναικός	καλλίονων	γυναικῶν
D.	καλλίονι	γυναικί	καλλίοσι	γυναιξί

Dual.

N. V. A. καλλίονε γυναῖκε

G. D. καλλίονοιν γυναικοῖν.

	Singular.		*Plural.*	
N.	μέλαινα	θρίξ	μέλαιναι	τρίχες
V.	,,	,,	,,	,,
A.	μέλαιναν	τρίχα	μελαίνας	τρίχας
G.	μελαίνης	τρίχος	μελαινῶν	τριχων
D.	μελαίνῃ	τρίχι	μελαίναις	θριξι

Dual.

N. A. V. μελαίνᾱ τρίχε

G. D. μελαίναιν τριχοιν.

(*Concluded on page* 312).

German.

A.

Louis 18th did not in the slightest degree present the appearance of that strong and determined personality one seeks upon a throne. Upon him nothing of the winning and taking disposition of his father, nor of the love of pomp (luxury) of his mother, had descended. About him was neither show nor comfort; his ante-rooms were empty of the nobility of the court that usually

throng around a king; his table was not particularly well supplied, his invitations were no objects for jealousy. He himself gave the impression of ill-health and weakness, and not seldom his illnesses broke out just when he most had needed health. Once, as he was announcing an edict to Parliament, that of all promulgated by him which met with most opposition, he was seized with a fever. Almost ironical sounded the flattery of one of his attendants, who said to him hereupon, that while making others tremble, he trembled himself. But he had, if we may say so, some negative virtues. As from all unthinking generosity, so he was also averse from any expense, not absolutely necessary, for himself. How insignificant and poor appears the hunting-seat that he had built at Versailles compared with the Luxembourg! More he did not allow himself. In the midst of thousandfold temptations, and despite the lax morality of the court, he kept himself morally unspotted. The only enjoyment to which he abandoned himself with pleasure was the chase, and from his youth he had a predilection for the army.

B.

The Emperor Maximilian I. was born in the year 1459. His was an agitated childhood and youth. As a small boy he had learnt, at Vienna, to know the horrors of a wearisome siege, and had had to share the necessities of his parents. From his Portuguese mother he had the fiery, easily excitable temper of a Southerner; his mental bias, his inclination for the extraordinary and the adventurous, his high-flown, not infrequently fantastic, ideas may also be thence derived. But his outward appearance, muscular form, firm walk, the fair hair and blue eyes, announced the German. German, too, were the innermost impulses of his mind and heart; besides these outer characteristics of the German, a high forehead, an eagle-nose, and a small mouth formed the peculiarities of his face. His voice was melodious and his address clever; it is thus easy to explain that at first sight his personality won all hearts and conciliated all inimical minds. His quick temperament certainly gave his teachers and educators much trouble where learning was concerned; on the other hand, even as a child, Maximilian was already a master in all corporal exercises and military games, bold and headstrong to absolute contempt of all danger, as he became more conscious of his bodily strength and agility. Besides the chase, he loved cheerful conviviality. Because of his delight in military games he has frequently been called "the last knight." It seemed as if it would not have been difficult for so gifted, and at the same time so aspiring, a prince to adorn himself with immortal crowns of fame.

C.

In Provence the sun is quite different from ours. He stands high in the dark-blue heavens, and no fog, not a cloudlet, restrains his almost perpendicular, all-submerging rays. In summer it hardly ever rains, and all vegetation succumbs beneath the burning heat till the evening dew refreshes it again to some extent. In midsummer not a green blade of grass is any longer to be seen, and the leaves on the trees scorched. Already, at the end of April, we found it almost as hot at Marseilles as it is with us in the warmest summer days, but the heat is less oppressive, because the air remains quite free from damp. The rays of the midday sun are very dangerous, often deadly. Therefore, as early as the beginning of May the footpaths round the harbour and the most frequented streets are covered over with linen awnings. About midday every act of life becomes enervated, all sink down, worn out. It is true a soft seabreeze rises daily, and continues from ten in the morning till evening, but in the town one hardly notices its refreshing breath; so the Marseillese flee to their country-houses, where the air blows about them more freely, although they there, too, find little comforting shade. The glory of the summer nights, on the other hand, is indescribable, especially when the full moon beams down from the clear, almost blue-black heavens, with a magnificence of which our coldest winter nights may give some idea. Then all hurry out, and one even sees respectable families (of rank, position) sitting in the streets in front of their house-doors, to enjoy the cool of the wonderfully beautiful night.

A.

1. When the nominative ends in *s*, names of persons take the article *des* for the genitive; in other words, the genitive takes an *s*; the other cases remain unchanged. Names of places take the preposition *von*, but this may be used in words both ending and not ending in *s*. Switzerland (*Die Schweis*) and Turkey (*die Turkei*) take the article, and are declined like common nouns.

Nom.	Heinrich	Moses	Spanien	Paris
Gen.	Heinrichs	des Moses	Spaniens	von Paris (or, von Spanien)
Dat.	Heinrich	Moses	Spanien	Paris
Acc.	Heinrich	Moses	Spanien	Paris

2.

N.	das grosse Kapital	die grossen Kapitalien
G.	des grossen Kapitals	der grossen Kapitalien
D.	dem grossen Kapital	den grossen Kapitalien
A.	das grosse Kapital	die grossen Kapitalien

dasselbe Individuum	dieselben Individuen
desselben Individuums	desselben Individuen
demselben Individuum	denselben Individuen
dasselben Individuum	dieselben Individuen

Kaiser Friedrich der Zweite	eine jüngere Tochter
Kaiser Friedrichs des Zweiten	einer jüngeren Tochter
Kaiser Friedrich dem Zweiten	einer jüngeren Tochter
Kaiser Friedrich den Zweiten	eine jüngere Tochter

3. Verbs of the strong conjugation form the past tense by changing the root vowel, and the past participle by prefixing *ge* to the infinitive, which sometimes also undergoes a vowel change—Tragen, trug, getragen; singen, sang, gesungen.

Verbs of the weak conjugation form the past tense and the past participle by adding something to the verb stem, and in the latter case prefixing *ge*—Kaufen, Kaufte, gekauft.

Du hebst	hobst	gehoben
hauest	hiebst	gehauen
fängst	fiengst	gefangen
stechst	stachst	gestochen
schwörst	schworst	geschworen
hälst	hielst	gehalten
reibst	riebst	gerieben
schwingst	schwangst	geschwungen

4. Antreffen—Er ist angetroffen. Morgentrifft er in Paris an. Einverleiben—Ich wünsche diesen Satz mit jenem einzuverleiben. Aufstehen—Sie sind aufgestanden. Wenn er herein kommt, stehen Sie auf.

5. Schlafen, sitzen, lachen, weinen.

Er ist geritten. He has ridden (of an event just happened).
Er hat geritten. ,, (of a habit, in past time).
Er ist gereist. He has travelled (here, *e.g.*, now).
Er hat gereist. ,, (in the past).

B.

1.

Definite. With meinige, etc., for *mine*, etc.
For the relative pronoun—Der Mann der im Zimmer war.
With jenige for *he who*.

Indefinite. As pronoun, einer, e, es.
As adjective, dieses eine Mal (this one time).
For *about*, ein drei Jahre.

2.

Helfen. Dative. Einem auf helfen, *to help one up*.
Fragen. Two accusatives. Einen etwas fragen, *to ask something of any one*.
Anklagen. Accusative of person, genitive of thing. Einen Mann des Stehlens anklagen, *to accuse a man of stealing*.
Nachdenken. Dative. Einem nachdenken, *to follow another's thoughts*. Uber etwas, *to think upon something*.
Sich ruhmen. Genitive, or mit. Sich ruhmen Reichthums, or mit Reichthum, *to glory in one's wealth*.
Sich verlassen auf, *to rely on*.
Verzichten auf, *to give up*.
Abhängen. Accusative, as an active verb, *to take off from*.

3. Four co-ordinative: und, *and*; oder, *or*; aber, *but*; sondern, *but* (after *not*). These and their fellow co-ordinatives cause no change in the construction of the sentence. Five subordinative: bis, *until*; als, *as*; nachdem, *after*; obgleich, *although*; seit, *since*. These and their fellows cause the finite verb to be thrown to the end of the subordinate clause. Three adverbial: wenn, *when*; wahrend, *whilst*; so bald (als), *as soon as*. These cause the same change of construction as the subordinate conjunctions, and are really not distinguishable from these.

Illustrative sentences:—

(*a*.) Mein Vater kann nicht kommen, aber meine Mutter wird kommen.

(*b*.) Die Leute arbeiteten auf dem Felde, bis es dunkel wurde.

(*c*) Er wäre ein Narr, wenn er deinem Rathe folgte.

4.
(1) Governed by a transitive verb—Der Koch hat den Kuchen.
(2) ,, certain prepositions, always — Durch das Dorf.
(3) ,, certain prepositions when the idea not of where but of whither is involved—Wir gehen in die Stadt.

5. Er ist bekanntlich reich (Man weiss dass er reich ist). Als er seine Aufgabe beendigt entfernte er sich ohne Abschied zu nehmen. Dieser Mann ist zu loben.

Latin Grammar.

1.

N.	mus	edax	mures	edaces
V.	mus	edax	mures	edaces
A.	murem	edacem	mures	edaces
G.	muris	edacis	murium	edacium
D.	muri	edaci	muribus	edacibus
A.	mure	edace	muribus	edacibus

N.	idem	jus	eadem	jura
V.	idem	jus	eadem	jura
A.	idem	jus	eadem	jura
G.	ejusdem	juris	eorundem	jurum
D.	eidem	juri	eisdem	juribus
A.	eodem	jure	eisdem	juribus

N.	melius	poema	meliora	poemata
V.	melius	poema	meliora	poemata
A.	melius	poema	meliora	poemata
G.	melioris	poematis	meliorum	poematum
D.	meliori	poemati	melioribus	poematibus, and [poematis
A.	meliori (or, e)	poemate	melioribus	poematibus, and [poematis

N.	vis	quaedam	ista	palus	una pirus
V.	(wanting)		ista	palus	una pire
A.	vim	quamdam	istam	paludem	unam pirum
G.	(wanting)		istius	paludis	unius piri
D.			isti	paludi	uni piro
A.	vi	quâdam	istâ	palude	unâ piro

2.

	Gender.	*G. S.*	*G. P.*
fons	m.	fontis	fontium
pons	m.	pontis	pontium
vas	m.	vadis	vadum
,,	n.	vasis	vasorum
mos	m.	moris	morum
apex	m.	apicis	apicum
ordo	m.	ordinis	ordinum
linter	f.	lintris	lintrium
tuber	f. or n., ac'd'g to meaning	tuberis	tuberum
socer	m.	soceri	socerorum
tribus	f.	tribūs	tribuum

	Perfect.	*Future Part.*	*Pres. Inf*
parco	peperci	parciturum	parcĕre
jubeo	jussi	jussurum	jussĕre
aufero	abstuli	ablaturum	auferre
lego (3rd)	legi	lecturum	legĕre
,, (1st) (or)	legavi	legaturum	legare
pungo	pupugi	puncturum	pungĕre
pango	pepigi (pĕgi)	pacturum	pangĕre
tundo	tutudi (or)	tunsurum tusurum	tundĕre
undo (3rd)	fūdi	fusurum	fundĕre
,, (1st)	fundavi	fundaturum	fundare
rodo	rosi	rosurum	rodere
quaero	quaesivi	quaesiturum	quaerĕre

4.

INDICATIVE.

	prosum	*malo*	*vincio*	*rapio*	*gero*
Pres.	Prodes	mavis	vincis	rapis	geris
Imp.	Proderas	malebas	vinciebas	rapiebas	gerebas
Future	Proderis	males	vincies	rapies	geres
Perfect	Profuisti	maluisti	vinxisti	rapuisti	gessisti
Past Perf.	Profueras	malueras	vinxeras	rapueras	gesseras
Fut. Perf.	Profueris	malueris	vinxeris	rapueris	gesseris

IMPERATIVE.

Pres.	Prodes	(wanting)	vinci	rape	gere
Fut.	Prodesto	,,	vincito	rapito	gerito

SUBJUNCTIVE.

Pres.	Prodis	malis	vincias	rapias	geras
Imp.	Prodesses	malles	vincires	raperes	gereres
Perf.	Profueris	malueris	vinxeris	rapueris	gesseris
Past. Per.	Profuisses	maluisses	vinxisses	rapuisses	gessises

INFINITIVE.

(used for all persons.)

Imper.	Prodesse	malle	vincĕre	rapĕre	gerĕre
Perf.	Profuisse	maluisse	vinxisse	rapisse	gessisse
Fut.	Profuturum esse	(wanting)	vincturum esse	rapturum esse	gessurum esse

PARTICIPLE.

Imperf.	(wanting)	(wanting)	vinciens -ientis	rapturus -a -um	gessurus -a -um
Fut.	Profuturus -a -um	(wanting)	vincturus -a -um	rapiens -entis	gerens -tis

SUPINE.

vincĭtum	raptum	gestum
vincĭtu	raptu	gestu

5. 'Ut' and 'ne' are used with the subjunctive after verbs signifying *to command.*

Impero is followed by the accusative of the direct object and the dative of the person to whom the command is given—'Imperat hostibus obsides': 'He ordered hostages from the foe.'

Posco—Used with the accusative of the person asked, the accusative of the thing asked for, and the dative of person for whom asked—'Poscit Caesarem naves legioni': 'He asks of Caesar ships for the legions.'

Opus—Used with dative of person and nominative or ablative of thing needed—'Dux (or, duce) nobis opus est': 'We have need of a leader.'

Interest—The genitive is used with 'interest' to denote the person to *whom* a thing is important—'Quid Milonis intererat interfici Clodium?': 'What advantage was it to Milo that Clodius should be slain?' (*Cicero.*)

Circumdo—Used with the accusative of thing or person surrounded, and ablative of thing surrounding—'Circumdedit oppidum munitionibus': 'He surrounded the town with fortifications.'

Parco—Used with dative—'Te rogo sumptu ne parcas' (*Cic.*): 'I ask you not to spare expense.'

Pudet—The word representing the person who experiences the feeling is put in the accusative, that which stands for the source of the feeling in the genitive—'Sunt homines, quos infamiae suae non pudeat': 'There are men who are not ashamed of their infamy.'

Juvat—Accusative of person delighted; the source of delight is put as an accusative and infinitive—'Juvat me te valere': 'I am delighted that you are well.'

Egeo—Ablative or genitive of the thing needed—'Me egetur cibi (or, cibo)': 'I want food.'

Faveo—Used with the dative—'Favere Helvetiis' (*Caes.*): 'To favour the Helvetii.'

6. *Oreris*—verb, passive, subjunctive, present, singular, 2nd person, from oro, oravi, oratum, orare.
petiti—participle, perfect, passive, singular, masculine or neuter, genitive, from peto, petivi petitum, petere.
sceleris—noun, 3rd declension, singular, neuter, geni ive, from scelus.
ĕdo—verb, active, imperative, present, singular, 2nd person. Other forms: cedite, or cette.
sedulo—adverb or adjective; of three terminations, singular, masculine or neuter, dative or ablative, from sedulus, a, um.
necesse—adjective, indeclinable.
arcesse—verb, active, imperative, present, singular, 2nd person, from arcesso, ivi, itum, ĕre.
nequisse—verb, neuter, infinitive, perfect, contracted form of nequivisse, from nequeo, nequivi, nequitum, nequire.
moriare—verb, neuter, subjunctive, present, singular, 2nd person, from morior, mortuus sum, moriri.
morare—verb, deponent, imperative, present, 2nd person, singular, from morari, moror, moratus sum.

7. *Cānis*—a dog, nom. or gen. sing.
cānis—dative or ablative plural, from cānus, white.
mālis—dative or ablative plural of mālus, a, um, bad.
mālis—dative or ablative plural of mālum, i, an apple; or 2nd pers. sing., present, indicative of malo.
ĕdit—3rd pers. sing., present, indicative, from ĕdo, ĕdi, ĕsum, to eat.
ĕdit—3rd pers. sing., present, indicative, from ēdo, didi ditum, dĕre.
lăbor—nominative singular of lăbor, oris, labour.

lăbor—1st pers. sing., present, indicative, from lăbor, lapsus, to slip, fall down.
dĭcat—3rd pers. sing., present, subjunctive, from dĭco, avi, atum, I devote.
dĭcet—3rd pers. sing., future, indicative, from dĭco, xi, ctum, to say.

8. Errant si quicquam ab his praesidii sperent, qui suis rebus diffidant; nos tamen hoc sumus in Ciceronem populumque Romanum animo, ut nihil nisi hiberna recusemus, atque hanc inveterascere consuetudinem nolimus; licet vobis incolumibus per nos ex hibernis discedere, et, quascumque in partes velitis, sine metu proficisci.

Dixit: Vincerent, si ita vellent, neque se esse qui gravissime ex illis mortis periculo terreretur; hos sapientes futuros esse; si gravius quid accideret futurum esse ut rationem ab illo reposcerent.

(*a*) Puer promisit se pecuniâ sapiente usurum.
(*b*) Nemo scit quando hostes urbem aggrediantur.
(*c*) Dicit, te domum pluris quam possis solvere emisse.
(*d*) Credo Gallos legatum ut pacem petat mox missuros.
(*e*) Hic miles fortis Athenis Thebas ut oppugnato presidio subveniret iter biduo contendit.
(*f*) Postquam patriam magnâ fortunâ quinque et vigintos annos rexerat nobilem mortem in prælio contra hostes invadentes obiit.

French.

A.—The Youth of Alexander.

Alexander was born in the year B.C. 356. His father had just taken possession of a town named Potidæa, and he received, at the time of his son's birth, the news that one of his generals had beaten the Illyrians, and that his horses had carried off the prize of the course at the Olympic games. They were happy presages of the glory reserved to his son. . . . Alexander was placed under the care of the great philosopher Aristotle at the age of thirteen. The pupil felt the most vivid admiration for the master. 'He did not love him less,' said he, 'than his father.' For four years Alexander studied poetry and elocution, morals and politics, natural sciences, medicine, and astronomy. . . . Physical exercises, which are necessary to maintain the health of the body and to develop its vigour, held a great place in the education of Alexander. He was an excellent horseman. 'What horse are you going to lose there?' said he, one day, in the presence of Philip, who was refusing to buy a very fine animal which the grooms had not been able to break in. His father reproached him for blaming people of experience, as if he were abler than they. 'I shall tame that horse,' said Alexander, 'better than any one.' 'And if thou failest,' said Philip, 'what will be the penalty of thy presumption?' 'Ah! well, I will pay,' replied he, 'the price of the horse.' Alexander mastered the animal under the eyes of his father. Philip wept with joy thereat. 'Seek a kingdom worthy of thee,' said he, embracing him; 'Macedonia is not big enough for thee.' The horse is celebrated under the name of Bucephalus, or 'bull's head,' Alexander made it his war-charger, and later on he gave its name to one of the towns that he had founded.—*Van der Berg* (*Bibliothèque des écoles et des familles*).

B.—Pepin le Bref and the Lords of his Court (752).

In these times of ignorance, when brute force alone was appreciated, the small stature of Pépin le Bref excited the jeers of warriors still imbued with the coarse prejudices of the old Franks. The king resolved to confound those who laughed at his expense. There had been erected at the Abbey of Ferrières a sort of circus, where many wild beasts fought together. Suddenly a wild bull and a lion appeared, who fought with unparalleled desperation. Pépin, seated in a tribune and surrounded by the lords of his court, calmly contemplated this combat. The lion had already seized the bull by the throat, when the king said to his courtiers, 'If there were a warrior bold enough to separate these two redoubtable adversaries, would it not be a great act of bravery?' 'Certes, sire,' replied a lord; 'it would be more than bravery, it would be temerity.' Another added: 'There is no mortal in the world capable of attempting such an enterprise.' 'Who is he among you,' said Pépin, 'who will dare to jump alone into the arena to tear the lion from off the bull?' At these words all the lords lowered their eyes, and no one answered. Pèpin le Bref then descends quickly from the platform, dashes into the circus, and drawing his sword, plunges it up to the hilt in the throat of the lion, which fell dead at his feet; then, with a back stroke, cuts off the head of the bull. Then he looks proudly round at those who till now had seemed to despise him, and says to them, 'Learn that courage is not measured by size. Have you never heard say that David, who was not any taller than I, overcame the giant Goliath? Does it now seem to you that I can be your king?' Cries of admiration resounded from all sides; this was the only reply of the confounded lords.—*C. Hygin-Furcy* (*Le La Fontaine en action*).

C.—Louis XVI. and the Locksmith.

Louis XVI. had simplicity and even *bonhomie*, but he had, to a sufficient degree, a sense of dignity when he was not at his anvil with Gamin; he might play at being Vulcan, but he only appeared thus before a man whose trade it was to have black hands; and here is a fact which proves that Louis XVI. well understood the danger of ridicule:—He was one morning more actively occupied than usual, when the locksmith who worked with him, and who was named Jacques Derhin, began to scream with laughter while looking at him. The king asked him what amused him so. Derhin, still laughing, could not speak, but he showed Louis XVI. his own face, and thus indicated what so excited his merriment. As there was no looking-glass in the royal forge, the king passed into the adjoining room. As soon as he looked at himself, and could see his face tattooed in so strange a way that he was unrecognisable, he joined in the gaiety of Jacques Derhin, and began to laugh with that good, frank, and joyous laugh one knows so rarely beneath a crown. . . . But after having satisfied his own gaiety, the king thought he ought not to prolong that of his companion. 'Jacques,' said he to him, while giving him a louis d'or (about 20 francs), 'thou shalt drink to my health this evening at thy supper, with thy wife and thy children, but without telling them what has made us laugh so much; thou wilt not forget what I have just told thee, my lad?' and he emphasised the last word. This recommendation of Louis XVI. proves that he did not wish any one to laugh at him; this fear of ridicule pleases me in a king.—*Duchesse d'Abrantès.*

French Grammar.

1. Mère, fille, maîtresse, jument, vâche, reine, lionne, dame, femme, compagne, fille. Son général; c'etait là un heureux présage; l'œil. Les cous.

2. Heureuse, belle, habile, brève, grossière, ancienne. Cette, mortelle, toute, bonne, franche, dernière. Chrétiens, vifs, naturels, exigus, féroces, pareils, noirs, royaux.

3.			
	Bon	meilleur	le meilleur
		mieux	le mieux
	petit	plus petit	le plus petit
		moindre	le moindre
	mauvais	plus mauvais	le plus mauvais
		pire	le pire
	peu	moins	le moins
	mal	pis (or, plus mal)	le pis (or, le plus mal)
	bien	mieux	le mieux

Heureusement, grandement, naturellement, excellemment, grossièrement, anciennement, également, hardiment, seulement, franchement.

4. Trois cent-cinquante-six. Sept cent-cinquante-deux. Mil-huit cent-quatre-vingt-cinq; or, Dixhuit cent-quatre-vingt-cinq. Mardi, le seize juin.

'Vingt' and 'cent' take the *s* when they are preceded by another number that multiplies them—Quatre-vingts soldats.

Mille milles = one thousand miles.

5.		
	Un homme grand	= a tall man
	un grand homme	= a great man
	un vieux soldat	= an old soldier (in service)
	un ancien soldat	= an old soldier (retired)
	son propre visage	= his own face
	son visage propre	= his clean face.

6.	*Indicative.*		*Subjunctive.*	
Naquit	nait	naîtra	naisse	naquît
	naissent	naîtront	naissent	naquissent
venait	vient	viendra	vienne	vînt
	viennent	viendront	viennent	vinssent
reçut	reçoit	recevra	reçoive	reçût
	reçoivent	recevront	reçoivent	reçussent
battu	bat	battra	batte	battit
	battent	battront	battent	battissent
tinrent	tient	tiendra	tienne	tînt
	tiennent	tiendront	tiennent	tinssent
va	va	ira	aille	allât
	vont	iront	aillent	allassent
pu	peut	pourra	puisse	pût
	peuvent	pourront	puissent	pussent
riaient	rit	rira	rie	rît
	riions	riront	rient	rissent

parut	paraît	paraîtra	paraisse	parût
	paraissent	paraîtront	paraissent	parussent
assis	s'assied	s'assiéra	s'asseye	s'assît
	s'asseyent	s'assieront	s'asseyent	assient
mort	meurt	mourra	meure	mourût
	meurent	mourront	meurent	mourrissent

7.

Etaient	suis-je	sommes-nous
ressentit	ressens-je	ressentons-nous
aimait	aimé-je	aimons-nous
parut	parais-je	paraissons-nous
avait	ai-je	avons-nous
repondit	repondis-je	repondons-nous
entendu	entendis-je	entendons-nous
vaincu	vaincqu'-je	vainquons-nous

ne place pas	ne plaçons pas
ne tiens pas	ne tenons pas
ne dis pas	ne disons pas
ne fais pas	ne faisons pas
ne plonges pas	ne plogeons pas
ne mets pas	ne mettons pas
ne ris pas	ne rions pas
ne bois pas	ne buvons pas

8.

Je m'étais emparé	Je m'étais élancé
tu t'étais emparé	tu t'étais élancé
il s'était emparé	il s'était élancé
nous nous étions emparés	nous nous étions élancés
vous vous étiez emparés	vous vous étiez élancés
ils s'étaient emparés	ils s'étaient élancés
Je me serais regardé	Je me serais mis
tu te serais regardé	tu te serais mis
il se serait regardé	il se serait mis
nous nous serions regardés	nous nous serions mis
vous vous seriez regardés	vous vous seriez mis
ils se seraient regardés	ils se seraient mis

9. Naissant, né. Tenant, tenu. Allant, allé. Venant, venu. Paraissant, paru. Repondant, repondu. Abatant, abatu. Pouvant, pu. Comprenant, compris. Mettant, mis. Voyant, vu. Riant, ri. Connaissant, connu. Devant, dû. Buvant, bu. Plaissant, plu.

10. (*a*) 'L'exercice physique qui est nécessaire pour entretenir la santé du corps tint une grande place dans l'education d'Alexandre.' 'Celui qui avait paru le mépriser.' 'Un cri d'admiration retentit.'

(*b*) 'Si vous échouez, quelles seront les peines de vos présomptions? Eh bien, nous payerons les prix des chevaux.' 'Ils promenèrent alors fièrement leurs regards.' 'Aussitôt qu'ils se fussent regardés et qu'ils pussent voir leurs visages.'

Natural Philosophy.

1. A picture, ACDB, weighing 40 lbs., is hung with its upper (AB) and lower (CD) edges horizontal by a cord, AOB, fastened to its two upper corners, A, B, and passing over a nail O, so that the parts AO, BO of the cord AOB, at the two sides of the nail O, make an angle (AOB) of 60° with each other. Find the pull in the cord in pounds weight.

As ∠ AOB = 60° and AB is horizontal, ∠ OAB and ∠ OBA each = 60°, and △ OAB is equilateral.

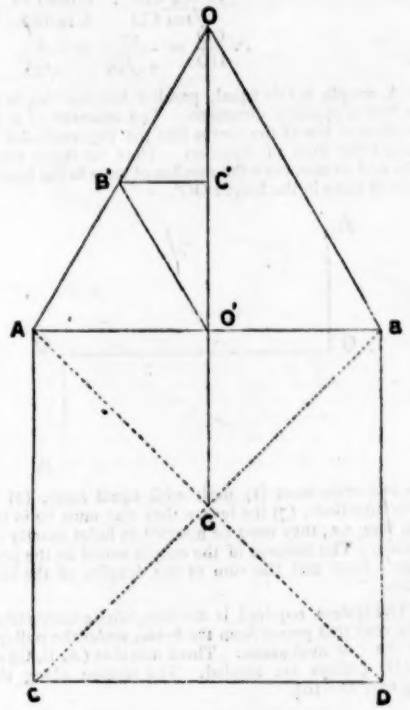
The centre of gravity of the picture (supposed uniform) is at the point of intersection, G, of its diameters, AD, CB. At this point the weight of the picture may be considered to be concentrated. As the weight of the picture acts vertically downwards, we have at O three forces: weight of picture, tension along AO, tension along BO, in equilibrium. The principle known as the triangle of forces comes into play.

Statement of this:—

If three forces acting on a point are in equilibrium, and any triangle be drawn whose three sides, taken in order, are severally parallel to, or perpendicular to, the direction of the three forces, the length of those sides will be proportional to the magnitude of the forces.

The three forces in equilibrium are the weight, 40 lbs., and the two tensions. The triangle required is △ OB'O', obtained by drawing through O' a line O'B' ∥ OB. Its side OO' is ∥ the direction of the weight of 40 lbs., O'B' to tension along BO, B'O to tension along AO, and the lengths of these three sides are as the magnitudes of the three forces. To find the relative lengths of these three sides, draw through B', B'C ∥ AB.

Consider ∠ B'OC. ∠ B'CO = 90°
∠ COB' = 30°
∠ OB'C = 60°



But in any △ whose angles are respectively 90°, 30°, 60°, the ratio of the lengths of the sides opposite those angles is 2, 1, $\sqrt{3}$.

∴ OC : CB' : B'O as 2 : 1 : $\sqrt{3}$.

OC represents 20 (as OO' represents 40)

∴ 2 ,, 20

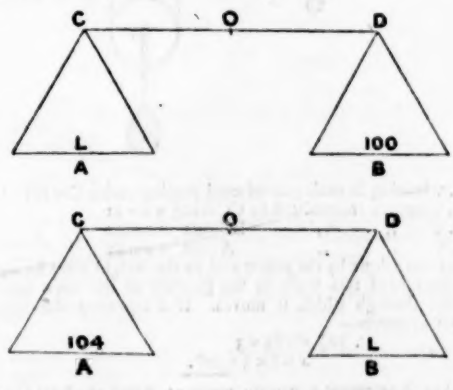
1 ,, 10

B'O or $\sqrt{3}$,, $10\sqrt{3}$

∴ tension along B'O = $10\sqrt{3}$

∴ ,, ,, AO and ∴ along BO = $\underline{20\sqrt{3}}$.

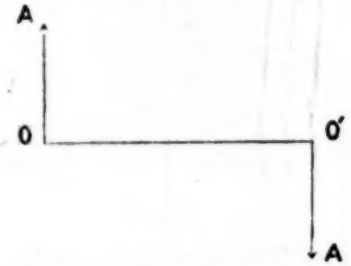
2. A piece of lead, L, placed in one pan, A, of a balance is counterpoised by 100 grams in the pan B; placed in B it is counterpoised by 104 grams. What is the ratio of the arms CO, OD of the balance?



A balance is a lever of the first order, having the fulcrum, O, between the two weights, whose points of suspension are C and D. The sum of the moments of the two weights about O will = zero.

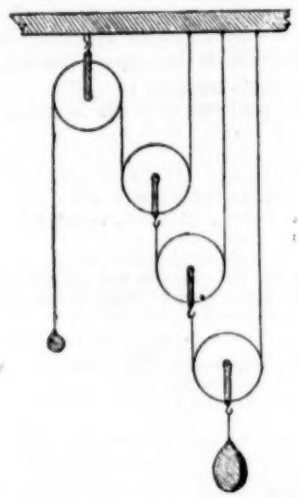
$\therefore L \times CO = 100\ DO$
and $L \times DO = 104\ CO$
$\therefore$ cross-multiplying $104\ L \times \overline{CO}^2 = 100\ L \times \overline{DO}^2$
$\therefore 104\ \overline{CO}^2 = 100\ \overline{DO}^2$
$\sqrt{104}\ CO = 10\ DO$
$\therefore \frac{CO}{DO} = \frac{10}{2\sqrt{26}} = \frac{5}{\sqrt{26}}$

3. A couple is two equal, parallel forces acting in the same plane, but in opposite directions. The moment of a couple is the product of one of the forces into the perpendicular distance between their lines of direction. Thus the figure represents a couple, and its moment = the number of units in the force A × the number of units in the length OO′.



The two men must (1) push with equal force, (2) push in opposite directions, (3) the levers they use must be in the same straight line, *i.e.*, they must be inserted in holes exactly opposite each other. The moment of the couple would be the product of one man's force and the sum of the lengths of the two levers they use.

4. The system required is the first, where each pulley has a separate cord that passes from the beam, under the pulley, to the axis of the one next above. Three movable (A, B, C) and one fixed (D) pulleys are needed. The tension along the cord passing over D = 10½.



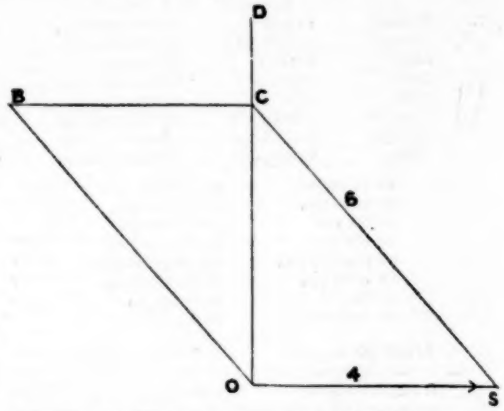
$\therefore$ tension in each part of cord passing under C = 10½
$\therefore$ tension transmitted to CC = 10½ × 2 = 21
$\therefore$ " " BC = 21 × 2 = 42
$\therefore$ " " A = 42 × 2 = 84

The work done by the power and by the weight must be equal. The measure of this work is the product of the mass and the distance through which it moves. If x represent the distance the power moves—

$\therefore 10\frac{1}{2}\ x = 84 \times 3$
$x = 8 \times 3 = 24$ ft.

5. Let O represent a certain point at which the boat is; OS the velocity of the river, 4 miles per hour. The velocity of the boat = 6 miles per hour. It is required to show the direction in which the head of the boat must be kept that its motion may be along the line OD at right angles to OS.

The problem is one in the Parallelogram of Velocities. State of this: If two velocities acting upon a point are represented in magnitude and direction by the two adjacent sides of a parallelogram, the diameter of that parallelogram drawn through the point will represent their resultant in magnitude and direction.



Describe a circle, with S as centre, and for radius a line whose length is 6 of the units of which OS = 4. Let C be the point where this circle cuts OD. Join SC. Through O draw OB ∥ to SC, and through C, CB ∥ to SO. OB is the direction required.

6. Let the acceleration (*i.e.* the change of velocity per second), be represented by a, the space traversed by s, the number of seconds during which the body moves by t. It is required to find the time of traversing the first, of traversing the second, of traversing the third, foot respectively.

The formula required is—

$$s = \frac{ft^2}{2}$$

In case (1) $1 = \frac{18 \times t^2}{2}$

$t^2 = \frac{1}{18}$
$t = \frac{1}{4}''$

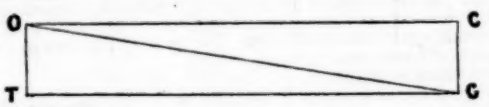
In case (2) we must first find how long t', the body, takes in describing 2 ft., and then subtract thence the $\frac{1}{4}''$ necessary for describing 1 foot.

$2 = \frac{18t'^2}{2}$
$t'^2 = \frac{4}{18} = \frac{2}{9}$
$t' = \sqrt{\frac{2}{9}}$ $\sqrt{\frac{2}{9}} - \frac{1}{4} = \frac{\sqrt{2}-1}{3}$

In case (3), by similar reasoning,

$3 = \frac{18t''^2}{2}$
$t''^2 = \frac{6}{18} = \frac{1}{3}$
$t'' = \frac{1}{\sqrt{3}}$ $\frac{1}{\sqrt{3}} - \frac{\sqrt{2}}{3} = \frac{\sqrt{3}-\sqrt{2}}{3}$

7. Let OT represent the 49 ft. in height of the tower. By the second law of motion (if a body be acted upon by two or more forces, each force has its full effect), the cannon-ball falls vertically just as if no other force acted on it. Hence we can find the time of its movement.



Formula $s = \frac{ft^2}{2}$

$49 = \frac{32t^2}{2} = 16t^2$
$7 = 4t$
$t = \frac{7}{4}''$.

To find OC, *i.e.*, the horizontal motion due to the shooting, we use the formula—

$s = Vt$ (where V is the uniform velocity)
$s = 50 \times \frac{7}{4} = 350$ ft.

TG, the distance from the tower at which the ball strikes the ground = 350 ft. The ball would not pass exactly along the line OG, but along a parabolic curve from O to G.

8. Let S represent a piece of silver (density 10·5) immersed in alcohol (density ·85); G, a piece of gold (19·3) immersed in nitric acid (1·5). The balance is in equilibrium. Required the relative masses of S and G.

Let these masses be represented by the letters S and G. The apparent weights of these are equal. But these equal in each case the weight of the metal—the weight of an equal volume of the fluid in which it is immersed.

$$\text{Weight of silver} = 10{\cdot}5S \text{ ; volume} = \frac{S}{10{\cdot}5}$$

$$\text{Apparent weight of silver} = 10{\cdot}5S - \frac{S}{10{\cdot}5} \times {\cdot}85$$

$$\text{Weight of gold} = 19{\cdot}3G \text{; volume} = \frac{G}{19{\cdot}3}$$

$$\text{Apparent weight of gold} = 19{\cdot}3G - \frac{G}{19{\cdot}3} \times 1{\cdot}5$$

$$\therefore S\left(10{\cdot}5 - \frac{{\cdot}85}{10{\cdot}5}\right) = G\left(19{\cdot}3 - \frac{1{\cdot}5}{19{\cdot}3}\right)$$

$$\therefore \frac{S}{G}\text{ (relative masses)} = \left[19{\cdot}3 - \frac{1{\cdot}5}{19{\cdot}3}\right] \div \left[10{\cdot}5 - \frac{{\cdot}85}{10{\cdot}5}\right]$$

$$= \frac{19{\cdot}3^2 - 1{\cdot}5}{19{\cdot}3} \div \frac{10{\cdot}5^2 - {\cdot}85}{10{\cdot}5}$$

$$= \frac{19{\cdot}3^2 - 1{\cdot}5}{29} \div \frac{10{\cdot}5^2 - {\cdot}85}{15}$$

$$= \frac{370{\cdot}99}{29} \div \frac{109{\cdot}4}{15}$$

$$= \frac{371\text{ (nearly)} \times 15}{109{\cdot}4 \times 29} = \frac{5565}{3172{\cdot}6}$$

9. When a body floats immersed in any fluid, or fluids, two forces are in equilibrium. One is the weight of the floating body, acting vertically downwards. The other is the weight of the fluid, or fluids, displaced, acting vertically upwards.

In the first instance, the wood floats in water (its lower part) and air (its upper part). It is ∴ buoyed up by a force = the weight of the volume of water (say v) displaced + the weight of the volume of air (say v) displaced.

In the second instance oil (a heavier fluid than air) replaces the air. Hence the weight of a volume, v', of oil is more than that of the same volume of air. The wood, therefore, now floats with a less volume (say v'') than v, immersed in the water, and a greater volume (say v''') than v' in the oil. The condition of equilibrium is that the weight of the wood = the weight of the volume v'' of water displaced + that of the volume v''' of oil displaced.

10. Take a glass tube not less than 8 decimetres long, and not less than a centimetre in diameter. Fill it with mercury. Place the finger on the open end. Invert the tube, and plunge the open end into a quantity of mercury in a vessel. Remove the finger from the open end. Some of the mercury falls out of the tube, and a column of about 76 centimetres is left in it. This is clearly kept up by the pressure of the air outside transmitted through the mercury in the vessel to that in the tube. Any increase of atmospheric pressure is followed by a rise of the mercury in the tube. Any diminution of the pressure by a fall.

The area of the tube and the density of glycerine:—From the latter can be calculated the weight of a cubit unit of glycerine. Let this be represented by w, the area in square inches by a, the height by h. Then $15a = wh$, for

15 lbs. = the pressure exerted by a column of height, h, on the square inch, and if the area of the tube is a square inches, where a is < or > 1, the pressure of the weight wh will be a times 15.

11. First, an image is formed by reflection from the front surface of the plate-glass. Second, an image is formed by reflection from the back surface of this. Third, an image is formed by reflection from the surface of the mercury behind the glass.

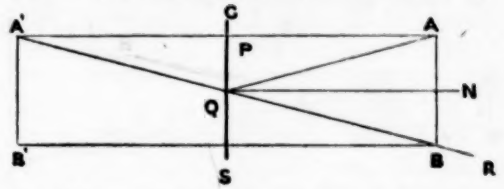
The third is the brightest, as a rule, because the metal mercury is a much better reflector than glass.

The reflected light in all three cases follows the two laws of the reflection of light:—

(1) The incident ray, the normal to the surface at the point of incidence, and the reflected ray are all in the same plane.

(2) The angle of incidence = the angle of reflection.

How the image is formed in each of the three cases will be understood by reference to Fig. 8.



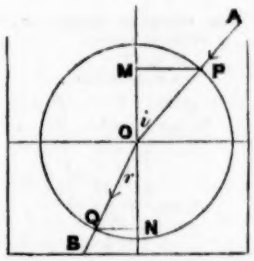
Let AB be a man, GS a mirror. From A draw AP, at right angles to GS; then the image of A is in AP, or AP produced. This is reflected back on itself. From A draw QA to any point Q. From Q draw QN at right angles to GS. From Q draw QR, making ∠ NQK = ∠ NQA. Then the image of A will be in PA, or PA produced, and QR or QR produced.

∴ The image of A will appear as at A', where AP and RQ produced meet.

In a similar way it can be shown that B will appear as at B'.

∴ A'B' represents the image of AB.

12. When light passes from a rarer medium into a denser, it is refracted or bent towards the perpendicular. The ratio of the side of the angle of incidence (*i.e.*, of the angle included between the incident ray and the normal to that of the angle of refraction—*i.e.*, the angle included between the refracted ray and normal) is a constant for any two given media, and is known as the refractive index for those two media.



To find the relation between ∠ of incidence and ∠ of refraction. With centre O, and any distance, describe a circle, cutting the lines of the incident and refracted rays and the normal. From P and Q draw Pm and Qn at right ∠s to Mn.

$$\text{Then } \frac{Pm}{PO} = \text{sine of } i$$

$$\frac{Qn}{QO} = \text{sine of } r$$

$$\text{but } PO = QO \text{ (radii)}.$$

∴ the ratio of the sine of angle of incidence and ∠ of refraction $= \frac{Pm}{Qn}$.

The ratio of Pm to Qn, if the media are vacuum and glass = 1·5; if they are vacuum and water = 1·33.

To understand what is called the critical angle, we must study the passage of light from the denser medium, glass or water, to the rarer; ∠ r now becomes the angle of incidence, and ∠ i that of refraction. As the angle of incidence increases, that of refraction becomes more and more nearly a right angle. When it is a right angle, and the refracted ray just glints along the surface of the glass, the angle of incidence is called the critical angle, or limiting angle of refraction. Whenever the incident angle is > the critical angle no refraction occurs, but the light is totally reflected into the denser medium, as if the surface of that were a mirror.

With glass and vacuum, the index of refraction = 1·5.

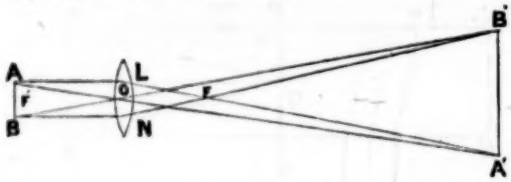
$$\therefore \text{ at the critical angle } (\theta)\ 1{\cdot}5 = \frac{\sin 90^\circ}{\sin \theta}$$

$\therefore$ $1{\cdot}5 \sin\theta = \sin 90°$ (i)
With water and vacuum index $= 1{\cdot}33$
$\therefore$ at the critical angle θ', $1{\cdot}33 = \dfrac{\sin 90°}{\sin\theta'}$
$\therefore$ $1{\cdot}33 \sin\theta' = \sin 90°$ (ii)
$\therefore$ from (i) and (ii) we have

$$1{\cdot}5 \sin\theta = 1{\cdot}33 \sin\theta'$$
$$\therefore \frac{1{\cdot}5}{1{\cdot}33} = \frac{\sin\theta'}{\sin\theta}$$

$\therefore$ critical angle is greater for water.

13. Fig. 10 represents what takes place.



Let AB be the object. Only the two points A and B are considered, and only two rays from each.

From A draw a line passing through O, the optical centre. (Rays through optical centre are not refracted.)

$\therefore$ the image of A will be in AO, or AO produced. From A draw a line $\parallel$ C'C. This ray is refracted to F (the principal focus). The image of A must be in the line LF, or LF produced; $\therefore$ image of A is at A', where LF and AO produced meet. In a similar way it can be shown that B' is the image of B, $\therefore$ A'B' is the image of AB.

Two formulæ are required.

(1) $\dfrac{\text{I (size of image)}}{\text{O (size of object)}} = \dfrac{\text{distance of image from lens}}{\text{distance of object from lens}} = \dfrac{v}{u}$

(2) $\dfrac{1}{u} + \dfrac{1}{v} = \dfrac{1}{f}$ where u, v, f, are distance of object, distance of image, focal length.

By (1) $\dfrac{\text{I}}{\text{O}} = \dfrac{8}{1}$ $\therefore \dfrac{v}{u} = \dfrac{8}{1}$ $\therefore v = 8u$.

The distance from object to image—*i.e.*, $u + v = 12$ ft.,

$$\therefore u + 8u = 12.$$
$$9u = 12$$
$$u = \tfrac{4}{3}, \text{ and } v = \tfrac{32}{3}$$

$\therefore$ the lens must be placed $\frac{4}{3}$ ft. $= 1$ ft. 4 in. from candle.

$$\text{By (2)} \quad \frac{1}{\frac{4}{3}} + \frac{1}{\frac{32}{3}} = \frac{1}{f}$$
$$\therefore \frac{3}{4} + \frac{3}{32} = \frac{1}{f}$$
$$\therefore 25f + 3f = 32$$
$$\therefore 27f = 32$$
$$\therefore f = \tfrac{32}{27} = 1\tfrac{5}{27} \text{ ft.}$$

14. The distance from A to D is to remain constant. The iron rod BA expands towards A; the iron rod CD towards D. The expansions of these tend to carry A and D apart. But the expansion of the zinc rod BC tends to carry A from right to left, and D from left to right. Hence its expansion must compensate the expansion of a theoretical rod equal in length to BA + CD.

If the expansion co-efficients of iron and zinc are represented by i and z respectively, $(BA + CD)\, i = BC z$.

$$\therefore \frac{BC}{BA + CD} = \frac{i}{z}$$

or the length of the rod BC is to the sum of the lengths of AB and CD as the co-efficient of expansion of iron is to that of zinc.

15. When any solid is converted into the corresponding liquid, a quantity of heat disappears, or becomes latent or potential. When ice is turned into water, heat becomes potential.

If 1 gram ice at 0°C is turned into 1 gram water at 0°, 80 thermal units (about) disappear. A thermal unit is that quantity of heat which will raise 1 gram of distilled water from 0° to 1°C.

The heat that becomes latent would raise the temperature of the mass of water formed through 80°C.

One hundred spaces on the Centigrade scale (from freezing to boiling point) are equivalent to 180 (32° to 212°) on the Fahrenheit.

1 on the centigrade to $\frac{180}{100} = \frac{9}{5}$ on the Fahrenheit
80 " " $\frac{9}{5} \times \frac{80}{1} = 144$ "

Latent heat of water $\therefore = 144$, when temperatures are measured on the Fahrenheit scale.

16. (1) If a poker, or any bar of any metal, is put into a fire at the same time as a bar of wood, and the other ends of the metallic and of the wooden bar held in the hands, the hand on the metal perceives the rise of temperature before that on the wood.

(2) Take two similar bars of silver and of tin. At the same distance from an end of each place a piece of phosphorus. Subject the other ends of both to the same source of heat. The phosphorus on the silver catches fire before that on the tin.

(3) Fill two similar test-tubes with mercury and with water respectively. Apply the same source of heat to the bottoms, holding the test-tubes in the same way in the two hands. That with the mercury becomes too hot to be held before the other.

Chemistry.

1. The formula for olefiant gas, also known as ethene, or heavy carburetted hydrogen, is C_2H_4.

C_2H_4 implies that olefiant gas is a compound made up of two atoms of carbon and four atoms of hydrogen.

C_2H_4 has weight number 28 ($C = 12$ $\therefore C_2 = 24$; $H = 1$ $\therefore H_4 = 4$), which means that 28 parts by weight of C_2H_4 occupy 22·4 litres at 0°C and 760 mm. pressure, as it is a compound gas. Its specific gravity compared with hydrogen $= \frac{28}{2} = 14$, and with air $\frac{14}{14{\cdot}46}$.

2. When sulphuric acid is poured on limestone, calcium sulphate, carbon dioxide, and water are formed.

$$CaCO_3 + H_2SO_4 = CaSO_4 + CO_2 + H_2O.$$

Calcium sulphate occurs as a mineral, termed anhydrite, gypsum alabaster, plaster of Paris.
Colourless.
Soluble in 400 parts of water.
Not combustible.

Carbon dioxide is a gas; can be condensed to liquid under great pressure, or by cooling to very low temperature.
Colourless, inodorous.

Specific gravity $= 22$, or $\dfrac{22}{14{\cdot}46}$.

Rather soluble in water. In effervescent waters and wines, much CO_2 is dissolved under great pressure.

Incombustible; does not support combustion of bodies in general, such as wood, sulphur, or phosphorus, but certain metals, such as potassium and magnesium, will decompose it, uniting with its oxygen.

Combines with lime-water, forming calcium carbonate, a white precipitate.

$$CO_2 + CaH_2O_2 = CaCO_3 + H_2O.$$

Water, a liquid, freezing at 0°, boiling at 100°C.
Colourless, tasteless, inodorous.
Specific gravity $= 1$.
Universal solvent.
Not combustible.
Occurs in large quantities in nature.

Sulphuric acid, when poured on copper, forms copper sulphate, sulphur dioxide, and water.

$$Cu + 2H_2SO_4 = CuSO_4 + 2H_2O + SO_2.$$

Copper sulphate is a blue coloured salt.

Sulphur dioxide; gas, easily liquefied; colourless, irritating odour, soluble in water, forming hydrogen sulphite or sulphurous acid ($SO_2 + H_2O = H_2SO_3$); not combustible, nor a supporter of combustion; acid.

Sulphuric acid and zinc form zinc sulphate and hydrogen.
Zinc sulphate is a salt.
Hydrogen is a gas very difficult to liquefy.
Colourless, tasteless, inodorous.

Specific gravity $= 1$, or $\dfrac{1}{14{\cdot}46}$ compared with air.

Almost insoluble in water.
Combustible, forming water ($2H_2 + O_2 = 2H_2O$), but does not support combustion.

Sulphuric acid and fluor-spar form calcium sulphate and hydrogen fluoride.

$$H_2SO_4 + CaF_2 = CaSO_4 + 2HF.$$

Calcium sulphate has already been discussed.

Hydrogen fluoride is a gas, liquefies at $-20°$; colourless. The liquid acts very violently upon the skin, producing painful wounds. Specific gravity $= 10$, or $\dfrac{10}{14{\cdot}46}$.

Soluble in water, dissolves with a hissing noise. Not combustible.

Used for etching on glass.

Sulphuric acid and common salt form sodium sulphate or sodium hydrogen sulphate and hydrochloric acid.

$$H_2SO_4 + 2NaCl = Na_2SO_4 + 2HCl.$$
$$H_2SO_4 + NaCl = NaHSO_4 + HCl.$$

Sodium sulphate occurs in mineral springs, and is used in medicine.

Hydrochloric acid is a gas easily liquefied.

Colourless, very irritating, acid odour and smell.

Specific gravity $= 18\frac{1}{4}$, or $\frac{18\frac{1}{4}}{14{\cdot}46}$.

Very soluble in water, one part of water dissolving 454 of acid.

Incombustible, and does not support combustion.

It is the only known compound of hydrogen and chlorine.

3. Symbols of carbon burning—

$$C + O_2 = CO_2$$
$$12 + 32 = 44.$$

∴ 12 by weight of carbon need 32 of oxygen.

1 " " needs $\frac{32}{12}$ "

$\frac{9055}{100}$ " " " $\frac{32 \times 9055}{12 \times 100} = \frac{2896}{12} = 241\frac{7}{12}$.

Symbols of hydrogen burning—

$$2H_2 + O_2 = 2H_2O$$
$$4 + 32 = 36.$$

∴ 4 by weight of hydrogen need 32 of oxygen.

1 " " needs $\frac{32}{4}$ "

$\frac{414}{100}$ " " " $\frac{32 \times 414}{4 \times 100} = \frac{828}{25} = 33\frac{3}{25}$.

∴ 100 parts by weight of the coal require altogether for combustion $241\frac{7}{12} + 33\frac{3}{25}$ of oxygen $= 274\frac{1}{3}\frac{3}{6}$.

But the coal already contains $2\frac{88}{100}$, *i.e.*, $2\frac{7}{25}$ of oxygen.

∴ 100 of coal only require of added oxygen $274\frac{1}{3}\frac{3}{6} - 2\frac{7}{25} = 272\frac{711}{300}$, and 1 ton of coal requires $272\frac{711}{300} \div 100$.

23 of oxygen are present in 100 by weight of air.

1 " " $\frac{100}{23}$ " "

$\frac{272\frac{711}{300}}{100}$ " " $\frac{100}{23} \times \frac{272\frac{711}{300}}{100}$ "

$$= \frac{272\frac{711}{300}}{23}$$
$$= \frac{81671}{300} \times \frac{1}{23}$$
$$= 1{\cdot}18 \text{ about.}$$

4. $FeS + H_2SO_4 = FeSO_4 + H_2S$

$$88 + 98 = 152 + 34$$

(22·4 litres)

22·4 litres of H_2S require 88 grs. of FeS

1 litre " " $\frac{88}{22{\cdot}4}$ "

i.e., a little less than 4 grams.

When sulphuretted hydrogen is led into solution of chlorine, hydrochloric acid and sulphur are formed.

$$2H_2S + 2Cl_2 = 4HCl + S_2.$$

Led into solution of ammonia (ammonium hydrate), water and ammonium hydrogen sulphide are formed.

$$H_2S + H_4NHO = H_2O + H_4NHS.$$

5. Nitrogen oxide, or laughing gas, N_2O, may be obtained by heating ammonium nitrate in a flask, like that used for the preparation of oxygen.

The gas is best collected over warm water. The salt decomposes on heating into nitrogen monoxide and hydrogen oxide.

$$NH_4NO_3 = N_2O + 2H_2O.$$
$$\underbrace{14 + 4 + 14 + 48}_{80} = 44 + 36$$

(2 vols.)

It is known by its sweet taste, being at the same time colourless and inodorous. It is also known by being able to support combustion. Diluted, it is a stimulant; pure, an anæsthetic.

To determine its composition, fill a glass jar with the gas, and in it burn a piece of phosphorus. The phosphorus will unite with the oxygen of the N_2O, forming phosphorus pentoxide, and the nitrogen will remain free.

$$5N_2O + P_2 = 5N_2 + 2P_2O_5.$$

Two volumes of N_2O yield two volumes of nitrogen and one of oxygen.

To determine molecular weight, weigh 22·4 litres of the gas at 0°C and 760 mm. Their weight in grams is, by the law of volumes for compound gases, the molecular weight of the compound; in this case, 44.

6. The halogens are derived from the sea-salts. (Halogens comes from Gr. ἅλς, ἁλος, sea-salt; and γενναω, I produce.) Chief salts are sodium, potassium, and magnesium chlorides, bromides, iodides.

Chlorine is prepared by heating a chloride and manganese dioxide with sulphuric acid. The products are manganese sulphate, a sulphate of the metal combined with the chlorine water and chlorine.

$$2NaCl + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2$$

Bromine can be prepared in a similar way from potassium bromide, manganese dioxide, and sulphuric acid.

$$2KBr + MnO_2 + 2H_2SO_4 = K_2SO_4 + MnSO_4 + 2H_2O + Br_2.$$

Iodine can be prepared, in a similar way, from potassium iodide, manganese dioxide, and sulphuric acid.

$$2KI + MnO_2 + 2H_2SO_4 = I_2 + K_2SO_4 + MnSO_4 + 2H_2O.$$

Iodine solution may be known from its light-brown colour and chlorine-like smell.

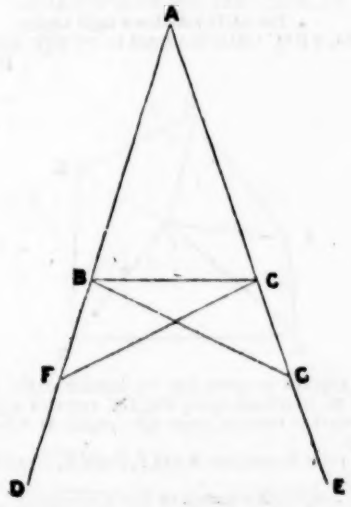
Bromine, known from its reddish-black colour, with very strong, irritating smell, and acting as a strong poison when inhaled; also causing spitting of blood.

Chlorine is known by its green-yellow colour, with a disagreeable smell.

The solutions heated will give off respectively greenish-yellow chlorine, reddish-yellow bromine, and violet iodine vapours. All three solutions bleach—chlorine most, iodine least. Iodine solution + starch gives a violet colour.

Geometry.

1. *Applied Enunciation.*—The angles ABC and ACB at the base BC of the isosceles triangle ABC are equal to each other; and if the equal sides AB and AC are produced to D and E the angles DBC and ECB, on the other side of the base BC, are equal.



Construction.—In BD take any point F, and along AE cut off AG = AF. Join B and G, and C and F.

Proof.—Consider the triangles ABG and ACF.

∵ AF = AG (construction)
AB = AC (hypot.)
∠BAG = ∠CAF (same angle)
} ∴ by I. 4, the two triangles are equal in every respect.

∴ BG = FC,
and ∠ACF = ∠ABG,
and ∠AFC = ∠AGB.
And ∵ AF = AG, and AB = AC;
∴ BF = CG.

Consider the △'s BCG and CBF.

FB = GC
FC = GB
and ∠CGB = ∠BFC
} ∴ by I. 4, the two triangles are equal in every respect.

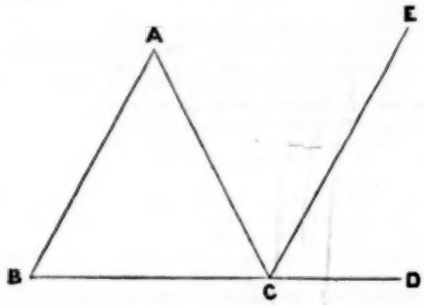
∴ ∠FBC = ∠GCB.

And since it has been shown that
∠ABG = ∠ACF,
and that ∠GBC = ∠FCB,

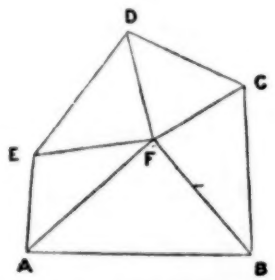
∴ the remainders ABC and ACB are equal, which are the angles at the base BC of the triangle ABC.

And it has also been shown that the angles FBC and GCB, on the other side of the base BC of the triangle ABC, are equal.
Q. E. D.

2. *Applied Enunciation.*—Prove that the three interior angles ABC, BCA, and CAB of the triangle ABC are equal to two right angles.

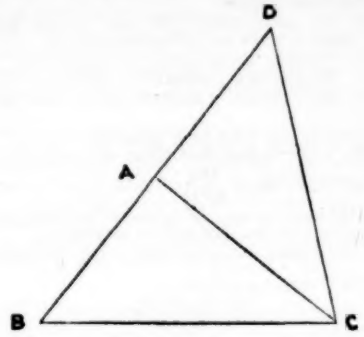


Construction.—Produce the side BC of the triangle ABC to any point D.
From C draw the line CE ‖ to the side BA.
Proof.—BA is ‖ CE, and BD falls across them;
∴ internal ∠ ABC = external and opposite ∠ ECD.
BA ‖ CE and AC falls across them,
∴ ∠ BAC = alternate ∠ ACE,
∴ we have the two angles
ABC and BAC = ECD and ACE.
But ECD + ACE = ACD,
∴ ABC + BAC = ACD.
To each of these add the angle ACB.
∴ ABC + BAC + ACB = ACD + ACB.
But ACD + ACB = 2 right angles.
∴ ABC + BAC + ACB are equal to two right angles.
Q. E. D.



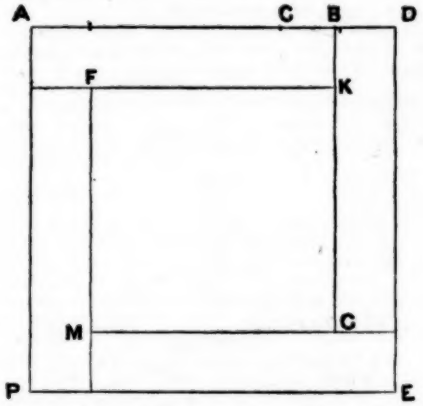
Also it is required to prove that the interior angles E, D, C, B, and A of the rectilineal figure ABCDE, together with 4 right angles, are equal to twice as many right angles as ABCDE has sides (viz. 5).
Take any point F, and join A and F, B and F, C and F, D and F, and E and F.
∴ ABCDE = broken up into 5 triangles.
By the preceding proposition, all the angles of these triangles are equal to twice as many right angles as there are triangles, that is, as the figure has sides.
∴ ABCDE contains 10 angles = right ∠'s.
But 4 of these right ∠'s are about the point F.
∴ ∠'s A, B, C, D, E + 4 right ∠'s = 10 right ∠'s.
∴ the interior ∠'s + 4 right ∠'s = twice as many right ∠'s (10) as the figure has sides (5).

3. If the square on the side BC of the triangle ABC = the squares on BA and AC, the angle BAC is a right ∠.
Construction.—From A draw a line at right ∠s to AC.
From it cut off AD = AB.
Join D and C.
Proof.—∵ AD = AB.
∴ $\overline{AD}^2 = \overline{AB}^2$.
To each of these add $\overline{AC}^2$.
∴ $\overline{AD}^2 + \overline{AC}^2 = \overline{AB}^2 + \overline{AC}^2$.
But ∵ ∠ DAC is a right ∠.
∴ $\overline{DC}^2 = \overline{AD}^2 + \overline{AC}^2$.
∴ $\overline{DC}^2 = \overline{BC}^2$.



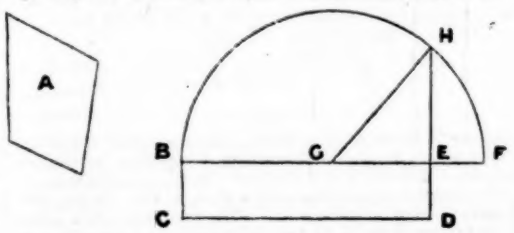
∴ DC = BC
and AD = AB,
and AC is common } by I. 8, the 2 △'s are equal in every respect.
∴ ∠ BAC = ∠ DAC.
But DAC is a right ∠,
∴ ∠ BAC is a right ∠. Q. E. D.

4. Required to prove that 4 times the rectangle contained by the whole line AB and one of its parts BC, together with the square on the other part AC = the square on the line made up of AB and BC (viz., AD).



AE represents a square on the line made up of AB + BC, BC = BD. FG is a square = the square on AC. And FG is surrounded by 4 equal rectangles, AK, DG, EM, and PF, all of which = AK. AK = AB, BC.
∴ AK, DG, EM, PF + FG = AE.
$4AK + \overline{FG} = \overline{AD}^2$.
$4AB, BC + \overline{AC}^2 = \overline{AD}^2$.
$4AB, BC + \overline{AC}^2 = (AB + BC)^2$.
Q. E. D.

5. Required to describe a square = the rectilineal figure A.



Describe the rectangle BD = A (I. 45).
Then if BE = ED, BD is a square, and what was required is done.
But if BE be not equal to ED, produce BE to F, making EF equal to ED.
Bisect BF at G; and with G as centre, and distance GF or GB, describe the arc BHF.
Produce DE to meet the arc at H.

Then the square on EH will be equal to A.

Join G and H.

Proof.—∵ BF is divided into two equal parts at G and two unequal parts at E,

∴ the rect. BE, EF + $\overline{GE}^2$
= $\overline{GF}^2$
= $\overline{GH}^2$
= $\overline{GE}^2$ + $\overline{EH}^2$.
∴ BE, EF + $\overline{GE}^2$ = $\overline{GE}^2$ + $\overline{EH}^2$.

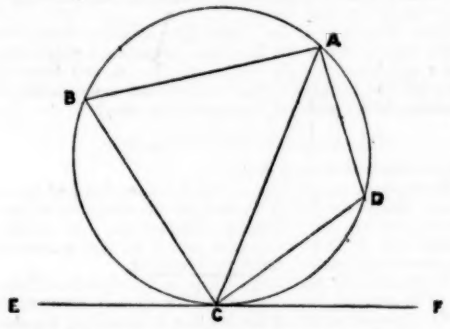
Taking away the common part $\overline{GE}^2$ from both sides of the equation, we have—

BE, EF = $\overline{EH}^2$,
But BE, EF = BD.
BD = A.
∴ A = $\overline{EH}^2$.

Therefore square on EH is equal to the rectilinear figure A.

Q. E. F.

6. The angle ABC of the segment ADC and the angle ADC in the segment ADC are together equal to 2 right angles.



At C draw the tangent ECF to the circle ABCD.

Proof—

∠ ADC = ∠ ACE (32, III.).

∠ ABC = ∠ ACF (32, III.).

∴ ADC + ABC = ACE + ACF; but ACE + ACF = 2 right angles (13, I.).

∴ ADC + ABC are equal to 2 right angles.

Q. E. D.

7. The condition is that the quadrilateral be a square or a rhombus. The method and proof for the square are as follows:—

Let ABCD be the given circle.

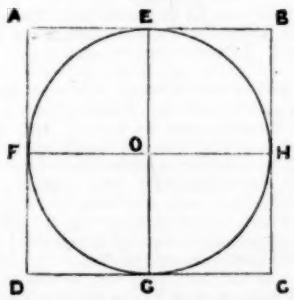
Bisect AB, AD in E and F, and draw EG ∥ AD or BC, and FH ∥ AB or DC.

Let EG and FH intersect at O. Then OA is a parallelogram,

∴ OE = FA, and OF = EA.

But ∵ AB = AD, and E, F are middle points of AB and AD;

∴ FA = EA,
and OE = OF.

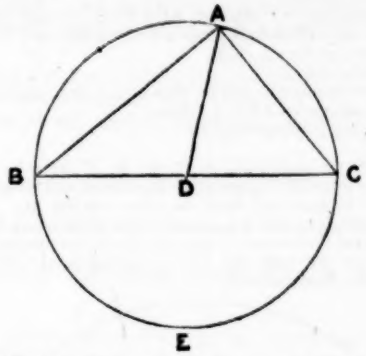


Similarly, it may be shown that OG = OF, and OH = OE, and ∴ OE, OF, OG, and OH are all equal, and a circle described with centre O and distance OE will pass through E, F, G, and H, and it will be touched by each of the sides of the square, ∵ ∠'s at E, F, G, H are right ∠'s. Thus a circle EFGH may be described in the square ABCD.

8. Required to prove that in the right-angled triangle ABC the line AD joining the right angle BAC to the middle point D of the hypotenuse BC is half the hypotenuse BC.

Proof—

∴ ∠BAC is a right ∠; it will be contained in a semicircle (31, III.).



BC is bisected at D.

∴ with centre D and distance DB or DC describe the circle BACE.

And because D is centre of the circle, and DB, DA, and DC are radii,

∴ they are equal to one another.

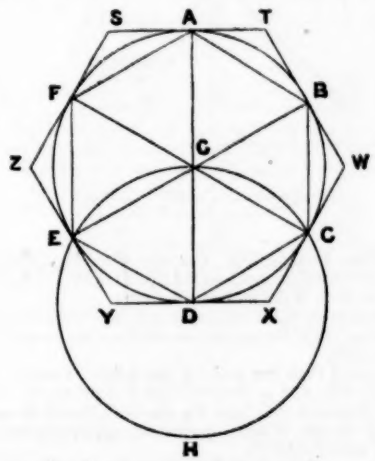
∴ DA = DB.

But DB = $\frac{1}{2}$ BC;

∴ DA = $\frac{1}{2}$ BC.

Q. E. D.

9. Required to describe an equilateral hexagon about a circle.



First inscribe a hexagon in a circle.

Let ABCDEF be the given circle.

Find the centre, G of the circle ABCDEF (1, III.), and draw the diameter AGD; from the centre D, at the distance DG, describe the circle EGCH; join E and G, C and G, and produce them to the points B, F; and join A and B, B and C, C and D, D and E, E and F, F and A.

Then hexagon ABCDEF shall be equilateral and equiangular. For, because G is centre of circle ABCDEF, GE is equal to GD; because D is centre of circle EGCH, DE = DG.

∴ GE = DE, and △EGD is equilateral, therefore the three ∠'s EGD, GDE, DEG are equal to one another. But the three ∠'s of a triangle are together equal to 2 right ∠'s; therefore ∠ EGD is the third of 2 right ∠'s.

In a similar way it can be shown that the ∠ DGC is a third of 2 right ∠'s.

And ∵ the line GC makes with EB the ∠ EGC, and ∠ CGB together = 2 right ∠'s.

∴ ∠ CGB is $\frac{1}{3}$ part of 2 right ∠'s.

∴ ∠'s EGD, DGC, CGB are equal to one another, and the vertical opposite ∠'s BGA, AGF, FGE are equal.

∴ The six ∠'s EGD, DGC, CGB, BGA, AGF, and FGE are equal to one another.

But equal ∠'s stand on equal arcs (36, III.).

∴ The six arcs AB, BC, CD, DE, EF, FA are equal to one

another. And equal arcs are subtended by equal straight lines (39, III.).

∴ The six straight lines are equal to one another, and the hexagon is equilateral.

It is equiangular, ∵ the arc AF = ED; to each add arc ABCD; ∴ arc FBD = ACE, and ∠ FED stands on FBD, and ∠ AFE stands on the arc ACE.

∴ ∠ FED = ∠ AFE.

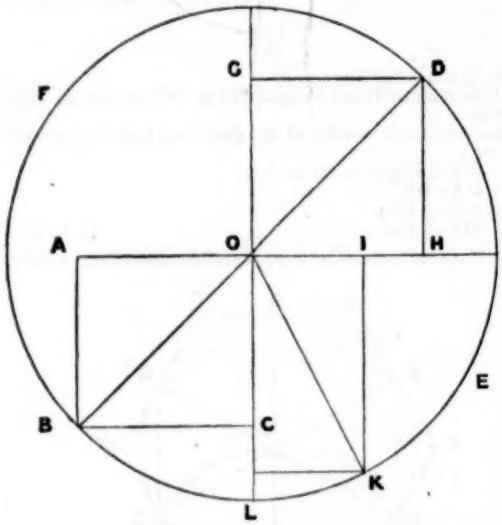
In the same manner it may be shown that the other ∠'s of the hexagon are each = AFE or FED.

∴ The hexagon is equiangular.

Secondly—

If through the points A, B, C, D, E, F there be drawn straight lines touching the circle, an equilateral and equiangular hexagon will be described about the circle (see Fig. 9).

10. Let AOCB represent a square. It is required to find the path of a point that moves so that the sum of the squares on its distances from the sides AO, OC of the square AOCB = twice the area of the square AOCB.



Construction.—Produce BO. Cut off OD = BO. With O as centre and OD as radius, describe the circle DEF. The circumference of this circle is the path of the circle.

Proof.—Square AOCB = square on AO, and = square on BO; ∴ twice square AOCB = square on BO = square on any radius of the circle DEF.

Take any point D in the path of the point. From it draw perpendiculars DG, DH to the sides CO, OA produced. These lines are the distances of D from the sides OC, OA of the square OACD. But the sum of their squares = (I. 47) square on OD = twice area of square AOCD.

In a similar way the sum of the squares on the distance KI, IO of any other point K in the path may be shown to be = twice the square AOCB.

When the point is at KL its distance from OC = zero. But its distance from AO = ∠ O = BO.

Greek—*continued from p.* 301.

II. GRAMMAR.—(*Continued.*)

3.

ἡδύς (sweet)	ἡδίων	ἥδιστος
μέγας (great)	μείζων	μέγιστος
ἀγαθός (good)	βελτίων	βέλτιστος
καλλός (beautiful)	καλλίων	κάλλιστος

For the comparative adverb the neuter singular of the comparative adjective is used; for the superlative adverb the neuter plural of the superlative adjective:—

ἡδίον (more pleasantly)	ἥδιστα (most pleasantly)
σοφώτερον (more wisely)	σοφώτατα (most wisely)

4.

Present.	*Future.*	*Perfect.*	*Aor. I.*	*Aor. II.*
ἵημι	ἥσω	εἶκα	ἧκα	—
μέλλω	μελλήσω	μεμέλκα	ἐμέλλησα	—
εἴδω	εἰδ/σω	—	—	—
ἁμαρτάνω	ἁμαρτήσομαι	ἡμάρτηκα	—	ἥμαρτον
τίνω	τίσω	τέτικα	ἔτισα	—
βαίνω	βήσομαι	βέβηκα	—	ἔβην
μανθάνω	μαθήσομαι	μεμάθηκα	—	ἔμαθον
λαμβάνω	λήψομαι	εἴληφα	—	ἔλαβον
φέρω	οἴσω	—	ἤνεγκα	ἤνεγκον
ὄμνυμι	ὀμοῦμαι	ὀμώμεκα	ὤμοσα	—

5. ἄν with the indicative turns a positive assertion into a conditional one, dependent on circumstances.

With the optative, it turns the wish into a conditional assertion.

With relative pronouns or conjunctions the general effect is to make milder the accompanying word. Thus, with ὅφρα, ὡς, the sense of possibility of attainment is implied.

6. ὁ ἀγαθὸς ἀνήρ. The good man.
ὁ ἀνὴρ ἀγαθός. The man is good.

III.—PASSAGES FOR TRANSLATION FROM BOOKS NOT PRESCRIBED.

1. The Phœnician woman, asked why she alone of the rest would not have a golden dowry, said, 'Because the man's manhood is sufficient dowry for me.'

2. When Pharnabazos found Abydos and Sestos thus, he warned them that if they did not send away the Lacedæmonians he would begin war with them.

3. When these things had been done, auxiliary forces from Dionysius sailed down to the Lacedæmonians, more than twenty triremes; and they brought Keltoi and Iberai, and about 500 cavalry; but the cavalry, seeing marked and many (points of) antagonism, did not associate much with the army.

IV.—HISTORY AND GEOGRAPHY.

1. See analysis at head of Book II.

2. Theramenes, son of Agnon, was a philosopher and general of Athens. One of the Thirty Tyrants, he was singularly free from the cruelty that was their general characteristic. As result of his antagonism to their oppressive policy, he was accused by Kritias, and condemned to drink the hemlock.

3. Ægospotami, or the Goat's River, was a place near Lampsacus. The channel, some two miles broad, ran between the two. At Ægospotami the Athenian fleet were posted, watching Lysander, when he was besieging Lampsacus itself. This was in the year B.C. 405. As Ægospotami was an uninhabited place, to which all supplies had to be brought from Sestos, the Athenians were anxious to force Lysander to fight. He would not be drawn into a combat. The Athenians grew lax, and Lysander, making a sudden descent upon their fleet, captured nearly the whole of it. Practically this victory brought the Peloponnesian war to a close; it gave Lysander command of the Euxine, and therefore of the control of the supplies of Athens. One by one the Athenian cities were taken by him after the battle of Ægospotami.

4. The βουλή was the Senate. In the heroic age it was the Council of Chiefs and limiter of the authority of the kings. Under the Republic it consisted of 400 members of the higher classes. By the reforms of Clisthenes its members became 500, fifty from each of the ten new tribes. The ἐκκλεσία was the formal assembly of the citizens. This did not meet at fixed periods till the Clisthenes reforms.

5. After the fall of Athens, at the end of the Peloponnesian war, thirty men were chosen to draw up laws for the future government of the city and for its present rule. The chief of these men, known as the Thirty Tyrants, were Kritias and Theramenes, already mentioned. Lysander worked with them. The feeling against Sparta, and more especially against Lysander, now sprang up. King Pausanias of Sparta, with many of his countrymen, regarded Lysander and the Thirty equally unfavourably. Thrasybulus, an Athenian exile, led a small force from Thebes to Athens. He defeated the troops of the Thirty at Phylē. Then he took Piræus, and inflicting another defeat upon the army of the Thirty, put an end to their rule. For a while a government of ten of the anti-Kritias party was formed. An appeal by all parties to Sparta led to the decision that all the exiles from Athens should be re-admitted, and that there should be a general amnesty for all but the Thirty and the Ten.

6. Chios, an island in the Ægean Sea, off the coast of Ionia. Ephesus, a town in Ionia, close to the river Caustrus and to the sea. Lampsacus, a town in Troas, on the coast, facing the Chersonese. Mytilenē, a town on the east coast of the island of Lesbos. Byzantium, the modern Constantinople, on the Straits of the Bosphorus, and in the ancient Thracia. Calchedon, a town on the opposite shore to Byzantium, in Bithynia. Sellasia, in Laconia; Cleomenes was defeated here. Ægospotami, on the eastern coast of the Chersonese, opposite Lampsacus. Eleusis, a town on the sea-coast of Attica, at the north end of the Saronic Gulf. Phylē, a town in Attica, just south of the mountain chain.

Query Column.

RULES.

1. Each correspondent is restricted to *one question.* We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.*

Algebra.

1. J. B.—Solve :—

$$\left.\begin{aligned}\frac{1}{x}-\frac{1}{y}&=\tfrac{1}{6}\\ \frac{1}{y}+\frac{1}{z}&=3\tfrac{5}{6}\\ \frac{4}{x}+\frac{3}{y}&=\frac{4}{z}\end{aligned}\right\}$$ (*Todhunter's* 'Algebra for Beginners.')

$$\left.\begin{aligned}(1)\ \frac{1}{x}-\frac{1}{y}&=\tfrac{1}{6}\\ (2)\ \frac{1}{y}+\frac{1}{z}&=3\tfrac{5}{6}\\ (3)\ \frac{4}{x}+\frac{3}{y}&=\frac{4}{z}\end{aligned}\right\}$$

$$\left.\begin{aligned}(1)\ \frac{1}{x}-\frac{1}{y}&=\tfrac{1}{6}\\ (2)\ \frac{1}{y}+\frac{1}{z}&=3\tfrac{5}{6}\end{aligned}\right\}$$

Adding $\quad \frac{1}{x}+\frac{1}{z}=4$

$$\left.\begin{aligned}\frac{4}{x}+\frac{4}{z}&=16\\ (3)\ \frac{4}{x}+\frac{3}{y}-\frac{4}{z}&=0\end{aligned}\right\}$$

Adding $\quad \frac{8}{x}+\frac{3}{y}=16$

(1) × 3 $\quad \frac{3}{x}-\frac{3}{y}=\frac{1}{2}$

$$\frac{11}{x}=16\tfrac{1}{2}$$

$$\frac{1}{x}=\tfrac{2}{3}$$

$$\therefore\ x=\tfrac{3}{2}.$$

(1) $\quad \frac{1}{x}-\frac{1}{y}=\frac{1}{6}$

$$\tfrac{2}{3}-\tfrac{1}{6}=\frac{1}{y}$$

$$\frac{1}{y}=\tfrac{1}{2}$$

$$\therefore\ y=2.$$

$$\frac{1}{x}+\frac{1}{z}=4$$

$$\frac{1}{z}=4-\tfrac{2}{3}$$

$$=\tfrac{10}{3}$$

$$\therefore\ z=\tfrac{3}{10}.$$

2. EASTERTON.—In a Euclid paper A gets 160 marks, and B just passes. A gets full marks for book-work, and twice as many marks for riders as B gets altogether. Also B, sending answers to all the questions, gets no marks for riders and half-marks for book-work. Supposing it necessary to get ⅓ of full marks in order to pass, find the number of marks which the paper carries. (*Hamblin Smith.*)

Let x = No. of marks for Euclid paper;

Then $\frac{x}{5}$ = ,, ,, obtained by B,

And $\frac{2x}{5}$ = ,, ,, for book-work;

$$\therefore\ \frac{2x}{5}+\frac{2x}{5}=160$$

$$4x=800$$

$$\therefore\ x=200$$

∴ No. of marks of Euclid paper = 200.

3. CHUZZLEWIT.—If $2n+1$ terms of the series 1, 3, 5, 7, 9... be taken, then the sum of the alternate terms 1, 5, 9...will be to the sum of the remaining terms 3, 7, 11...as $n+1$ to n. (*Todhunter.*)

Sum of $(n+1)$ terms of 1, 5, 9...

$$=[(1\times 2)+\{(n+1)-1\}\times 4]\times\frac{n+1}{2}$$

$$=(2+4n)\times\frac{n+1}{2};$$

Sum of n terms of 3, 7, 11...

$$=\{(3\times 2)+(n-1)\times 4\}\times\frac{n}{2}$$

$$=(6+4n-4)\times\frac{n}{2}$$

$$=(2+4n)\times\frac{n}{2};$$

∴ First sum : Second sum :: $n+1$: n.

4. ANACOLONTHA.—If the m^{th} term of an A.P. be n, and the n^{th} term be m, of how many terms will the sum be $\frac{1}{2}(m+n)(m+n-1)$, and what will be the last of them?

If a = first term, and d = difference,

$$\left.\begin{aligned}(1)\ n&=a+(m-1)d\\ (2)\ m&=a+(n-1)d\end{aligned}\right\}$$

Subtracting $\quad n-m=(m-n)d$

$$(m-n)d=-(m-n)$$

$$\therefore\ d=-1.$$

$$(1)\ n=a+\{(m-1)\times -1\}$$

$$=a-m+1$$

$$\therefore\ a=m+n-1.$$

Let x = No. of terms;

Then $\frac{1}{2}(m+n)(m+n-1)$

$$=\frac{x}{2}\{2(m+n-1)-(x-1)\}$$

$$(m+n)(m+n-1)=x(2m+2n-2-x+1)$$

$$=x(2m+2n-1-x)$$

$$x^2-x(2m+2n-1)=-(m+n)(m+n-1)$$

$$x^2-x(2m+2n-1)+\left(\frac{2m+2n-1}{2}\right)^2$$

$$=(m+n)^2-(m+n)+(\tfrac{1}{2})^2-\{(m+n)^2-(m+n)\}$$

$$=\tfrac{1}{4}$$

$$x-\frac{2m+2n-1}{2}=\pm\tfrac{1}{2}$$

$$x=m+n-\tfrac{1}{2}\pm\tfrac{1}{2}$$

∴ $x=(m+n-1)$, or $(m+n)$.

In the former case the last term

$$=(m+n-1)+\{(m+n-1-1)\times -1\}$$

$$=m+n-1-m-n+2$$

$$=1.$$

In the latter case the last term

$$=(m+n-1)+\{(m+n-1)\times -1\}$$

$$=(m+n-1)-(m+n-1)$$

$$=0.$$

5. ESSAYIST.—Find a series of arithmetic means between 1 and 21, such that their sum has to the sum of the two greatest of them the ratio of 11 to 4.

Let n = total No. of terms;

Then,

$$\text{Sum} = (a+l)\times\frac{n}{2}$$
$$= (1+21)\times\frac{n}{2}$$
$$= 11n;$$
$$\therefore \text{Sum of means} = \underline{11n-22}.$$

Sum of the two greatest means
$= a+(n-2)d+a+(n-3)d$
$= \underline{2+(2n-5)d}.$

$\therefore 11n-22 : 2+(2n-5)d :: 11 : 4,$
$n-2 : 2+(2n-5)d :: 1 : 4,$
$4(n-2) = 2+(2n-5)d$
$4n-8 = 2+(2n-5)d$
$4n-10 = (2n-5)d$
$\therefore \underline{d=2}.$

$21 = 1+\{(n-1)\times 2\}$
$20 = 2n-2$
$2n = 22$
$\therefore \underline{n=11}.$

$\therefore$ There are 9 means, and they are $\underline{3, 5, 7 \ldots 19}$.

6. FELIX HOMO.—Given $\log 2 = \cdot 301030$, and $\log 3 = \cdot 477121$, find the logarithms of $\cdot 05$ and of $5\cdot 4$.

$$\text{Log } \cdot 05 = \log \tfrac{5}{100}$$
$$= \log 5 - \log 100$$
$$= \log \tfrac{10}{2} - 2$$
$$= \log 10 - \log 2 - 2$$
$$= 1 - \cdot 30103 - 2$$
$$= \cdot 698970 - 2$$
$$= \underline{2\cdot 698970}.$$

$$\text{Log } 5\cdot 4 = \log \tfrac{54}{10}$$
$$= \log 54 - \log 10$$
$$= \log (2\times 3^3) - 1$$
$$= \log 2 + 3\log 3 - 1$$
$$= \cdot 301030 + (\cdot 477121\times 3) - 1$$
$$= \cdot 301030 + 1\cdot 431363 - 1$$
$$= \underline{\cdot 732393}.$$

7. CYCLOPS.—Solve :—

$$\left.\begin{aligned} x^3+y^3+z^3+3a^3 &= 0\\ x+y+z &= 0\\ x^2y+b^3 &= 0 \end{aligned}\right\}$$ (*Science and Art*, Stage III., 1885.)

$$\left.\begin{aligned} &(1)\ x^3+y^3+z^3+3a^3=0\\ &(2)\qquad x+y+z=0\\ &(3)\qquad x^2y+b^3=0 \end{aligned}\right\}$$

$$(2)\quad (x+y+z)^3 = 0$$
$$x^3+y^3+z^3+3x^2y+3xy^2+3x^2z+6xyz+3y^2z+3xz^2+3yz^2 = 0$$
$$-3a^3+3x^2y+3xy^2+3x^2z+6xyz+3y^2z+3xz^2+3yz^2 = 0$$
$$x^2y+xy^2+x^2z+2xyz+y^2z+xz^2+yz^2 = a^3$$
$$xy(x+y+z)+xz(x+y+z)+y^2z+yz^2 = a^3$$

But, $x+y+z=0$ (2)
$\therefore \quad y^2z+yz^2 = a^3$
$xyz+y^2z+yz^2 = xyz+a^3$
$yz(x+y+z) = xyz+a^3$
$0 = xyz+a^3$
$\therefore \underline{xyz = -a^3}$. (4).

$$\left.\begin{aligned} &(3)\ y = -\frac{b^3}{x^2}\\ &(4)\ y = -\frac{a^3}{xz} \end{aligned}\right\}$$

$$\therefore \frac{a^3}{xz} = \frac{b^3}{x^2}$$
$$\frac{a^3}{z} = \frac{b^3}{x}$$
$$\therefore z = \underline{\frac{a^3x}{b^3}}.$$

$$(2)\quad x+y+z=0$$
$$x-\frac{b^3}{x^2}+\frac{a^3x}{b^3}=0$$
$$b^3x^3-b^6+a^3x^3=0$$
$$(a^3+b^3)x^3 = b^6$$
$$x^3 = \frac{b^6}{a^3+b^3}$$
$$\therefore x = \underline{\frac{b^2}{\sqrt[3]{a^3+b^3}}}.$$
$$z = \frac{a^3x}{b^3}$$
$$= \frac{a^3}{b^3}\times\frac{b^3}{\sqrt[3]{a^3+b^3}}$$
$$= \underline{\frac{a^3}{b\sqrt[3]{a^3+b^3}}}.$$
$$x+y+z=0$$
$$\frac{b^2}{\sqrt[3]{a^3+b^3}}+y+\frac{a^3}{b\sqrt[3]{a^3+b^3}}=0$$
$$y = -\frac{a^3+b^3}{b\sqrt[3]{a^3+b^3}}$$
$$= \underline{-\frac{(a^3+b^3)^{\frac{2}{3}}}{b}}.$$

8. ANNIE LINDSAY.—At what rate of compound interest would a sum of money be doubled in 16 years? (*Edinburgh Medical Examination.*)

Let R denote the amount of £1 in one year, P the principal, A the amount, and n the number of years;

Then $A = PR^n$,
$2P = PR^{16}$,
$2 = R^{16}$
$\therefore R = 2^{\frac{1}{16}}$
$\text{Log } R = \frac{\log 2}{16}$
$= \frac{\cdot 30103}{16}$
$= \cdot 018814375;$
$\therefore \underline{R = 1\cdot 0442\ldots}$

Amount of £100 in one year = £104·42...
$\therefore$ Rate per cent. = $\underline{4\frac{1}{2}}$ (nearly).

9. SCIPIO.—Given $\log 2 = \cdot 30103$ and $\log 3 = \cdot 47712$, find the number of years in which a sum of money will quadruple itself at 20% compound interest.

Let P denote the principal, A the amount, R the amount of £1 in one year, and n the number of years.

Then $A = PR^n$,
$\therefore 4P = P\,(\frac{6}{5})^n$
$4 = (\frac{6}{5})^n$
$\text{Log } 4 = n$ times $\log \frac{6}{5}$
$2\log 2 = n$ times $(\log 6 - \log 5)$
$\cdot 30103\times 2 = n$ times $\{\log(3\times 2) - \log \frac{10}{2}\}$
$\cdot 60206 = n$ times $\{\log 3 + \log 2 - (\log 10 - \log 2)\}$
$= n$ times $(\log 3 + \log 2 - \log 10 + \log 2)$
$= n$ times $\{\cdot 47712 + (\cdot 30103\times 2) - 1\}$
$= n$ times $(\cdot 47712 + \cdot 60206 - 1)$
$= n$ times $(1\cdot 07918 - 1)$
$= n$ times $\cdot 07918$
$\therefore n = \frac{\cdot 60206}{\cdot 07918}$
$= \underline{7\cdot 603\ldots}$
$\therefore$ Time $= 7\cdot 6$ years
$= \underline{7\frac{3}{5}}$ years. Ans.

10. SCIPIO.—Sum the series

$$\frac{1}{2.6}+\frac{1}{3.7}+\frac{1}{4.8}+\ldots \text{ to infinity.}$$

The nth term $= \frac{1}{(n+1)(n+5)}$
$= \frac{1}{4}\left(\frac{1}{n+1}-\frac{1}{n+5}\right);$

$\frac{1}{2.6} = \frac{1}{4}(\frac{1}{2}-\frac{1}{6});$
$\frac{1}{3.7} = \frac{1}{4}(\frac{1}{3}-\frac{1}{7});$
$\frac{1}{4.8} = \frac{1}{4}(\frac{1}{4}-\frac{1}{8});$
$\frac{1}{5.9} = \frac{1}{4}(\frac{1}{5}-\frac{1}{9});$
$\frac{1}{6.10} = \frac{1}{4}(\frac{1}{6}-\frac{1}{10})$, etc.

Adding,

$$\text{Sum to } n \text{ terms} = \tfrac{1}{4}\left(\tfrac{1}{2}+\tfrac{1}{3}+\tfrac{1}{4}+\tfrac{1}{5} - \frac{1}{n+2} - \frac{1}{n+3} - \frac{1}{n+4} - \frac{1}{n+5}\right);$$

$$\therefore \text{Sum to infinity} = \tfrac{1}{4}\left(\tfrac{1}{2}+\tfrac{1}{3}+\tfrac{1}{4}+\tfrac{1}{5}\right)$$
$$= \tfrac{1}{4} \times \frac{30+20+15+12}{60}$$
$$= \tfrac{1}{4} \times \tfrac{77}{60}$$
$$= \underline{\tfrac{77}{240}}. \quad \text{Ans.}$$

11. SOLICITOR.—From 256 gallons of wine a certain number are drawn and replaced hy water; this is done a second, a third, and a fourth time, and 81 gallons of wine are then left. How much was drawn out each time?

We have here a geometrical progression, where the first term = 256, the last term = 81, the number of terms = 5, and we require the common ratio.

$$l = ar^{n-1},$$
$$\therefore 81 = 256r^4$$
$$r^4 = \tfrac{81}{256}$$
$$r^2 = \tfrac{9}{16}$$
$$\therefore r = \tfrac{3}{4}$$

$\therefore$ Quantity drawn out each time—
$= \tfrac{1}{4}$ of 256 gals.
$= \underline{64 \text{ gals.}}$ Ans.

12. JONATHAN POLLITT.—If $a+b+c=0$, shew that $a^3+b^3+c^3=3abc$. (*Todhunter's* 'Algebra for Beginners.')

If $a+b+c=0$,
$$a+b=-c,$$
$$(a+b)^3=-c^3,$$
$$a^3+3a^2b+3ab^2+b^3=-c^3,$$
$$a^3+b^3+c^3=-3a^2b-3ab^2$$
$$=3abc-3a^2b-3ab^2-3abc$$
$$=3abc-3ab\,(a+b+c)$$
$$=3abc-(3ab\times 0)$$
$$=\underline{3abc}.$$

13. FIDES.—Solve:—

$$\sqrt{x+8}-\sqrt{x+3}=\sqrt{x}. \quad (\textit{Todhunter}.)$$
$$\sqrt{x+8}-\sqrt{x+3}=\sqrt{x}$$
$$\sqrt{x+8}=\sqrt{x}+\sqrt{x+3}$$

Squaring}
$$x+8=x+x+3+2\sqrt{x^2+3x}$$
$$5-x=2\sqrt{x^2+3x}$$
$$(5-x)^2=4(x^2+3x)$$
$$25-10x+x^2=4x^2+12x$$
$$3x^2+22x=25$$
$$x^2+\frac{22x}{3}=\tfrac{25}{3}$$
$$x^2+\frac{22x}{3}+(\tfrac{11}{3})^2=\tfrac{25}{3}+\tfrac{121}{9}$$
$$=\frac{75+121}{9}$$
$$=\tfrac{196}{9}$$
$$x+\tfrac{11}{3}=\pm\tfrac{14}{3}$$
$$x=\pm\tfrac{14}{3}-\tfrac{11}{3}$$
$$\therefore \underline{x=1, \text{ or } -\tfrac{25}{3}}.$$

The minus value is inapplicable, as it gives *impossible* roots.
$\therefore \underline{x=1}$. Ans.

14. COMPLEX.—A train travelling at the rate of 60 miles an hour meets another train twice as long travelling at the rate of 40 miles an hour, and passes it completely in 4½ seconds; find the length of the first train.

Let x = Length of first train in yards;
Then $2x$ = ,, second ,, ,, ;
Sum of rates of trains per second in yards
$$=\frac{(60+40)\times 1760}{60\times 60}$$
$$=\frac{100\times 88}{60\times 3}$$
$$=\tfrac{8800}{180};$$
$$\therefore (x+2x)\div\tfrac{8800}{180}=4\tfrac{1}{2}$$
$$3x\times\tfrac{180}{8800}=\tfrac{9}{2}$$
$$\frac{3x}{440}=\tfrac{1}{2}$$
$$3x=220$$
$$\therefore \underline{x=73\tfrac{1}{3}}.$$

$\therefore$ Length of first train = $\underline{73\tfrac{1}{3} \text{ yards.}}$ Ans.

Arithmetic.

1. CHARLIE.—£3,500 of 3 per cent. stock is left by will to be transferred to a person 18 months from the present date. Find the present value of the legacy, supposing the stock to be at 91½ during the 18 months, and the rate of discount to be 4½ per cent. (*Cambridge Senior*, December, 1867.)

$$£4\tfrac{1}{2} \times \tfrac{1}{91\frac{1}{2}} = £(\tfrac{9}{2}\times\tfrac{2}{183}) = £\tfrac{9}{183} = £6\tfrac{3}{61};$$

£ £ £
$\therefore$ 106¾ : 3500 :: 91½ : Present value.

4 4
427 366
61 6

$= \underline{£3,000}$. Ans.

2. MISTRESS.—A has £2 in half-crowns, and £1 in florins. In how many different ways can he pay £1 17s.?

No. of half-crowns = 16
,, florins = 10

There must be an even number of half-crowns, and it must leave an even number of shillings.

10 half-crowns = £1 5s.
6 florins = 12s. } £1 17s.

14 half-crowns = £1 15s.
1 florin = 2s. } £1 17s.

3. HAYDN BOOT, P.T.—A bill was drawn March 13th for £325 10s. at 9 months, and discounted July 23rd; find the discount at 3¾ per cent.

Bill is due Dec. 16th;
No. of days from July 23rd to Dec. 16th = 146;

$$£3\tfrac{3}{4} \times \tfrac{146}{11688} = \left(\frac{\overset{3}{\cancel{15}}}{\cancel{4}} \times \frac{\cancel{2}}{\cancel{8}}\right) £ = £1\tfrac{1}{2};$$
$$\overset{2}{}$$

£ £ £
$\therefore$ 101½ : 325½ :: 1½ : Discount.
2 2 2
203 651 3
29 93

3
2 | 279
29)£139 10s.(£4
116
23
20
470(16s.
20
180
174
0
12
72(2d.
58
14

$\therefore$ Discount = $\underline{£4\ 16\text{s.}\ 2\tfrac{14}{29}\text{d.}}$ Ans.

4. CIDER.—The length of a mean solar year being 365·242264 days, what is the daily motion of the mean sun? (*Evers.*)

days day degs.
365·242264 : 1 :: 360 : Daily motion of sun.
days degs.
365·242264) 360
60 min.
21600·000000(59
1826211320
3337886800
3287180376
50706424
60 sec.
3042385440(8·329
2921938112
1204473280
1095726792
1087464880
730484528
3569803520
3287180376
282623144

$\therefore$ Daily motion of sun = $\underline{59 \text{ min. } 8\cdot329\ldots \text{ sec.}}$ Ans.

5. —— The net rental of an estate, after deducting 7d. in the pound for income-tax, and 5 per cent. on the remainder for the expenses of collecting is £959 3s. 8d.; find the gross rental. *Barnard Smith.*)

Amount left out of £1 = $\frac{4}{5}\frac{7}{5}$ of 19s. 5d.

$$= \frac{19 \times 233}{20} \text{ d.}$$

$$= 4\frac{1}{2}\frac{7}{0}\text{d.};$$

d. £ s. d. £

$\therefore$ $4\frac{1}{2}\frac{7}{0}$: 959 3 8 :: 1 : Gross rental.

20

19183

12

230204

20 £

4427)4604080(1040. Ans.

4427

17708

17708

General.

1. W. A. S.—The solution of your query appeared in our issue for July, 1882.

2. DI CASTIGLIONI.—You will find the solution of your query in our issue for September, 1882.

3. PUZZLED.—Your query from 'Civil Service Arithmetical Paper' was solved in our issue for October, 1882.

4. FUZZLED.—The solution of your query from 'Comprehensive Standard Arithmetic' appeared in our issue for April, 1884.

5. CONSTANT READER.—You will find the solution of your query in our issue for March, 1885. For $xy = \pm 1$, or $-\frac{1}{2}$, read $xy = \frac{1}{2}$, or $-\frac{1}{2}$; and for $y = \frac{1}{2x}$, or $\frac{3}{2x}$, read $y = \frac{1}{2x}$, or $-\frac{3}{2x}$.

6. MAGISTER.—Your query was solved in our issue for May, 1882. Diameter = 7·92... inches.

7. MAY-FLOWER.—The solution of your query appeared in our issue for March, 1882.

8. W. R. BOWER.—(1) Your geometrical query was solved in our issue for April, 1883. 3 times angle AEF is proved to be equal to 4 right angles + angle AFE, as ED produced meets AB produced towards the base. If ED produced meets AB produced towards the vertex, then 3 times angle AEF = 2 right angles + angle AFE. (2) *Allen* and *Cornwell's* or *Morell's* 'Grammar.' (3) Thanks for pointing out the error.

9. JIM.—(1) 55 to 60. Curves all thick; pen held incorrectly. (2) Nouns are *collective* when they denote several individual things as one object; as herd, army. When collective nouns convey plurality of idea, and refer to the individuals making up the group, then they are called *nouns of multitude*. Example—The *public* are hastening to the city. *Abstract* nouns denote qualities or attributes. If an abstract noun is used to denote the persons possessing the quality then it is called *concrete*: *e.g.*, He was rejected on account of his *youth* (abstract). The *youth* of this country are being well trained (concrete).

10. SUNDERLAND.—You had better write to the Secretary of the Institution for information as to the questions. A beginner may be quite a boy or a young man. The books which would suit one would not necessarily suit the other. We name a few books, which we can recommend: 'Trigonometry,' *Todhunter's*, 2s. 6d.; *Lock's*, 4s. 6d.; *Pinkerton's*, 2s. 6d. 'Chemistry,' *Roscoe's*, 4s. 6d.; *Thorpe's*, 2s. 6d. 'Physics,' *Everett's*, 2s. 6d.; *Balfour Stewart's*, 4s. 6d. 'Music,' Manuals published by Novello and Co., all cheap.

11. IGNIS MONTIS.—The first and most important consideration is your health. You wont find it so easy to master your old enemy as you imagine, unless you take plenty of exercise and get some recreation. A walk with a book in your hand is not the thing. Then as to your list. It seems to us much too long. Could you not get more marks by taking fewer subjects and doing them better? Your knowledge of many of the subjects must be merely second-hand if you attempt so much. Books and lectures are excellent, but they are not enough. You should work practically at some of the subjects. In general dont attempt too much. Work hard while you work, and revise frequently. We will try to find the best book on the subject you name by next month.

12. THIRD YEAR P. T.—Large hand, 50; small hand, 60. Study good copies; you dont make the letters properly.

13. ANXIOUS.—Acting teachers can now only take second year's papers.

14. EXCELSIOR.—'Mackay's Geography' will suit you There is no syllabus for the examination you name other than the pupil teacher's course of study. See the Code, Schedule V.

15. X. Y. Z.—It is worth about 70.

16. HANNIBAL.—The Secretary, Cambridge Middle Class Examinations, Cambridge, is quite enough.

17. HEREFORD.—We cannot tell you the number of marks, nor can you get to know. We do not think it will be any advantage so far as the Scholarship Examination is concerned. Of course it is a good thing to get your full certificate as soon as possible. You cannot get the information from a book. You must practise, under direction if possible. If you cannot get that, make small sketches of common objects on paper, and then transfer them to the board. Watch carefully the drawing-lessons now passing through this magazine.

18. RALPHO.—Our advice to you is to keep doing a little at French each day, not with a view to take it at Christmas, 1885, but at Christmas, 1886. Unless you do fairly well at the examination, you get no marks at all in French. But that will not, of course, lower your marks in anything else. If you take it in 1885 you will be spending your time in reading the author. You would spend your time much better in studying the grammar and exercises and reading an easy book, such as La Fontaine's Fables, by Macmillan, or any similar compilation. You would be able to take the subject up next year with more chance of success.

19. CONSTANT READER.—We are a little surprised at your enquiry. You would not be rejected on account of health, unless, in the opinion of a very competent man, you would not be likely to bear the strain of two years' close study. Now, if you are unable to bear this strain on one side of the Thames, you are not likely to bear it on the other. Again, if it is usual to hold an examination in religious knowledge at the colleges you name, it is hardly likely that it would be dispensed with in your case. Why should it? Would it not be better to go where you are likely to be accepted in the first case. If your health is really unsatisfactory, accept the fact, and, having taken a medical opinion, go to some quiet, healthy place, and try to live under more favourable conditions. Depend upon it, health is more important than a high place on the list.

20. STUDENT.—*Deschanel's* 'Natural Philosophy' for Light, Heat, and Sound; *Twisden's* 'Mechanics.' Add if you like, *Thomson and Tait's* 'Natural Philosophy' (Introduction), and *Minchin's* 'Coplanar Statics.' *Garnett's* 'Dynamics' is excellent. See also *Todhunter's* 'Mechanics for Beginners.' You ask for the most complete Greek grammar. Surely that is not what you mean. Say what you want it for, and our best advice is at your disposal. Any geography will do. It is an important part of the examination. You want to know Europe and the British Colonies, and the places which are of interest at the time.

21. EX P. T.—Dont attempt too much. Study your grammar well. The primer of 'English Literature,' by *S. Brooke*, 1s., would be quite sufficient. It is a beautiful little book. Try *Mackay's* 'Geography.'

22. R. DUCKWORTH.—Thank you. The idea is a good one. We will try and do so. Publishers might object to an arbitrary selection. We will see about it.

23. SCYNTHEUS.—Most easily by writing to the heads of the colleges and asking. There is an introduction to the University by *Potts*, which gives the information; but you would do best to write.

24. COLONNA.—'Machiavelism of the age' means the artful, deceitful policy of the age. It is from the name of the famous Italian, who was noted for his cunning. Give us the reference for the other expression. We cannot find it.

25. X. Y. Z.—

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Exten. of Pred.
(*a*) Breathes there a man with soul so dead	Princ. Sent.		A man	breathes		with a soul so dead there
(*b*) Who never to himself hath said	Adj. Sent. to man (*a*)		who	hath said	to himself (ind.)	
(*c*) This is my own, my native land	N. Sent. to (*b*)		this	is my own, my native land		
(*d*) If such there be	Adv. Sent.	if	such	be there		
(*e*) Go	Prin. Sen.		(Thou)	go		
(*f*) Mark him well	Prin. Sen co-ord. with (*e*)		(Thou)	mark	him	well
(*g*) For him no minstrel raptures swell	Prin. Sen.		no minstrel raptures	swell	for him (ind.)	
(*h*) High though his titles, proud his name, boundless his wealth	Adv. Sent.	though	his titles, his name, his wealth	(be) high (be) proud (be) boundless		
(*i*) As wish can claim	Adv. Sent. to (*h*)	as	wish	can claim		
(*j*) Despite those titles, power and pelf, the wretch, concentred all in self, living shall forfeit fair renown	Prin. Sen.		the wretch concentred all in self living	shall forfeit	fair renown	despite those titles power and pelf
(*k*) And doubly dying, shall go down to the vile depths unwept, unhonoured and unsung	Prin. Sen. co-ord. with (*j*)	and	doubly dying (he) unwept unhon'r'd and unsung	shall go		down to the vile depths
(*l*) From whence he sprung	Adj. Sent. to (*k*)		he	sprung		from whence

There—introductory particle.
so—adv., qualg. 'dead.'
hath—irreg. trans. verb, indic. mood, present tense, 3rd, sing., agreeing with *who*.
said—past participle of 'to say.'
hath said—irreg. trans. verb, indic. mood, perfect tense, 3rd, sing., agreeing with its nom. *who*.
land—com. noun, neut. gen., nom. case, after the verb *is*.
wandering—pres. participle, used as noun, obj. case, gov. by 'from.'
breathe—reg. intrans. verb, subj. mood, present tense, 3rd pers., singular number, agreeing with 'such.'
go—irr. intrans. verb, imp. mood, 2nd, sing., agreeing with *thou*.
titles—com. noun, neut., gen., nom. case to verb *be*.
despite—preposition, governing 'titles' in next line.
all—adverb, qualifying 'concentred.'
concentred—participle, used as adjective, qualify. 'wretch.'
living—present participle, qualifying 'wretch.'
go—infinitive mood of the word 'to go.'
whence—adverb.
sprung—(Sprung is used for the rhyme instead of sprang) irreg. intrans. verb, past tense, ind. mood, 3rd, sing., agreeing with 'he.'
unsung—past participle used as adjective, qualifying *he*.

26. X. Y. Z. AND J. W.—The question has evidently been printed incorrectly, as

$$\begin{aligned} & ab(x^2+y^2)+(a^2+b^2)xy \\ =& abx^2+aby^2+a^2xy+b^2xy \\ =& a^2xy+abx^2+aby^2+b^2xy \\ =& ax(ay+bx)+by(ay+bx) \\ =& (ax+by)(ay+bx) \\ =& ay+bx\ ; \text{ and} \\ & (a-b)(x-y) \\ =& ax-bx-ay+by \\ =& (ax+by)-(ay+bx) \\ =& 1-(ay+bx). \end{aligned}$$

27. W. C. CHAPPEL.—The papers on 'Physiology' will shortly be resumed in the PRACTICAL TEACHER.

How to Teach Drawing in Elementary Schools.

BY T. R. ABLETT,
Superintendent of Drawing to the School Board for London.

DRAWING FOM MODELS.—II.

IN my last article I showed pretty fully how a first lesson should be given. The object dealt with was a map-sheet hung on a side wall. In the same way and with equal pains, three or four lessons should be given in drawing vertical planes of similar character. Experience shows that very careful lessons will produce better results, than those given in a slipshod way. One result of careless teaching is that pupils get hold of false notions which take a long time to correct, even when it is possible to eradicate them. It has been said to be more difficult to unlearn than to learn, and many teachers prefer an untaught pupil to one who has been badly taught.

The glass plane should always be used, and every time it is employed the pupils must see for themselves that the tracing is correct. This is of the utmost importance.

Below are two illustrations showing a second and third lesson.

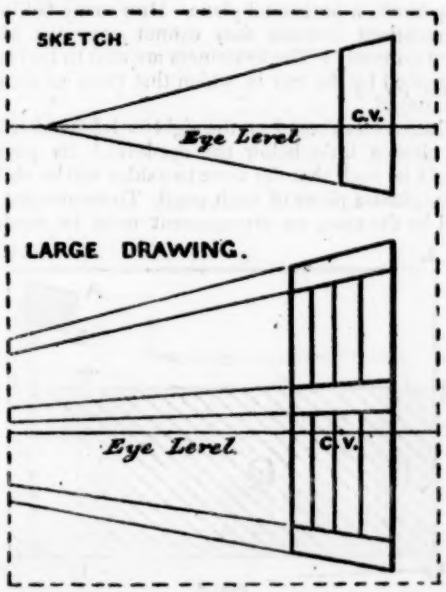


Fig. 6.

In Fig. 6. a door is represented. It may be in a side wall below the map-sheet already drawn ; or, if it be in a wall facing the pupils, it should be placed open towards them. In Fig. 7 a blackboard is shown, when it is placed on the floor against the side wall, in a position below the map-sheet.

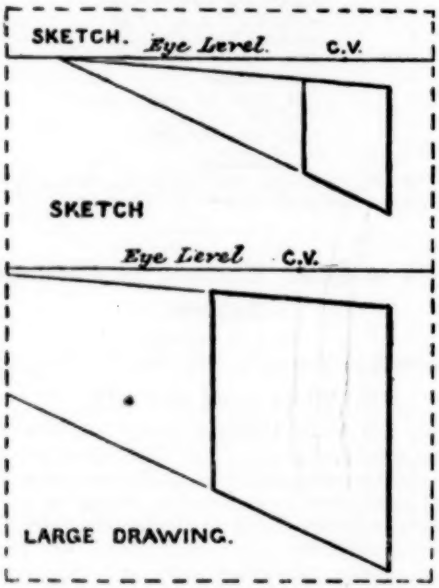


Fig. 7.

In the lessons already considered, the map-sheet gave us lines above the eye-level ; the door, lines above and below the eye-level ; and the blackboard, lines below the eye-level.

The objects have, so far, been placed at the right-hand side of the class. Lessons from similar vertical planes placed at the left-hand side of the class should also be given.

We now come to the drawing of that great stumbling-block, a horizontal plane. How many fail in the examinations because they cannot draw the blackboard correctly ! The examiners are said to be mainly influenced by the way in which that piece of drawing is managed.

Place a blackboard on the right or left hand side of the class, a little below the eye-level. Its position should be such that the same two sides will be oblique to the picture plane of each pupil. To secure that this shall be the case, an arrangement must be made as shown in Fig. 8, where LMNO represents a class-room, RSNO the seats used by the pupils, of which those marked TSNU should be unoccupied, in order that all the scholars may have approximately the same view of the two sides AB, BC of the blackboard. A vertical rod fixed in a block of wood,

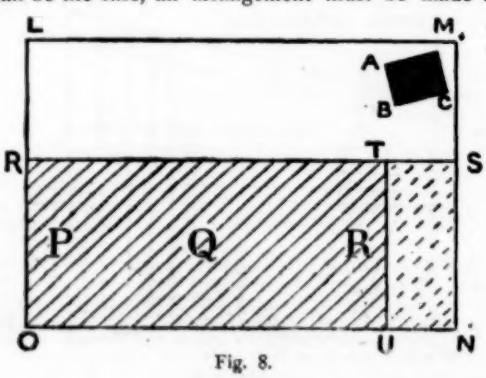


Fig. 8.

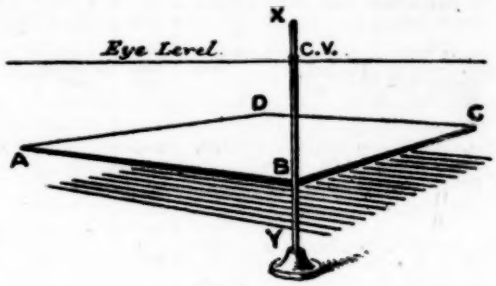


Fig. 9.

such as XY in Fig. 9, should be placed against angle B, and the actual average height of the eye of the scholars marked on it, as CV. Where the pupils are on platforms of different heights, CV_1, CV_2, CV_3, must be marked as before mentioned. When a tracing on the glass plane has been made and verified by each scholar, the eye level for the sketch should be drawn near the top of each paper, and the nearest point of the black board B indicated by a dot. This may be placed about an inch below the eye level. Those who sit near Q in Fig. 8, will find it convenient to mark B half-way between the left and the right hand side of the paper. Those who sit near P will do well to place B nearer to the right-hand side of the paper, and those who sit near R should place B nearer the left-hand side of the paper. Request the members of the class to hold their pencils or measuring rods at arm's length on the imaginary glass planes placed between them and the model, in a horizontal position shown by the dotted

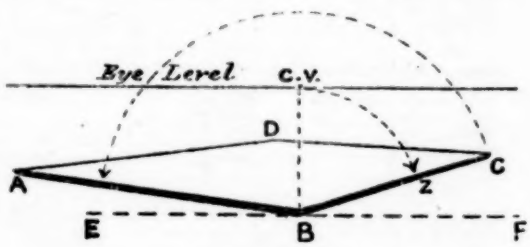


Fig. 10.

line EF in Fig. 10. The apparent size of the angle ABE should be ascertained by comparing it with the angle AB (CV). Those who sit near R in Fig. 8, will find angle AB (CV) appears less than angle ABE. To those who sit near Q, the two angles will appear equal, but to those who sit near P, the angle AB (CV) will appear greater than ABE.

Dot the horizontal line EF, and draw a line from B up to the eye level, making it slope as AB appears to slope. In a similar way find the slope of BC, and draw it to the eye level. The slope of these two lines is of the greatest importance. Nine times out of ten, pupils make the angle ABC much too acute.

Let the pupils measure the distance from B to (CV)

Fig. 10, on the pencil or measuring rod, held vertically. The top of the pencil should be in a line with CV, and the end of the thumb opposite B. Without moving the thumb let the pencil be revolved flat on the imaginary glass plane, so that the thumb will still be opposite B, and the end of the pencil opposite Z.

(The distance B (CV) measured from the object, will not be the same as that allowed in the sketch.)

It should be noted how much BZ is of BC. Those who sit near R (Fig. 8) will find BZ much less than BC, but those who sit near P will discover no great difference, and BZ may even be apparently greater than BC. When this comparison has been carefully made, point C should be marked on the sketch.

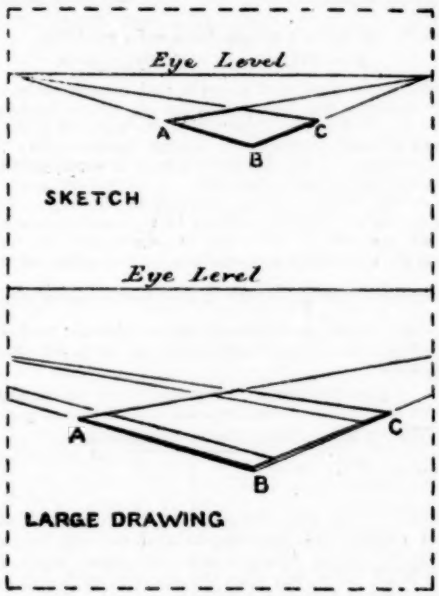


Fig. 11.

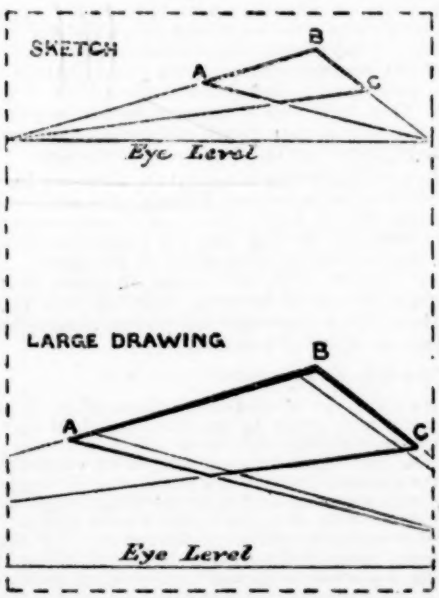


Fig. 12.

Now let the end of the pencil be held opposite to C, and the end of the thumb placed opposite to B. Keeping the pencil flat on the imaginary glass plane, revolve it so that the end will be at W, and the thumb still opposite B. This will show how BC compares with BA. To those who sit near R (Fig. 8) BC will appear greater than AB, but to those who sit near P, the side AB will appear greater than BC. Let point A be marked.

From the tracing made by the teacher on the glass plane, the pupils have learned that AD appears to meet BC in a point on the eye level, and that DC appears to meet AB in a similar way. There will be no difficulty in completing the drawing of the black board. For a next lesson it should be drawn when placed above the eye level. In fact, it should be represented several times at different distances, above and below. Figs. 11 and 12 show two complete drawings.

(To be continued.)

—o—

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER XI.

COMPOUNDS OF NITROGEN. LAW OF MULTIPLE PROPORTIONS.

Compounds with oxygen; of these five are known. A list of their names, symbols, and weight-numbers follows :—

Nitrogen oxide (nitrous oxide), laughing gas...	N^2O	44
,, dioxide (nitric oxide)	N^2O^2 (better NO)	30
,, trioxide (nitrous acid)	N^2O^3	76
,, tetroxide (nitric peroxide)	N^2O^4 (better NO^2)	46
,, pentoxide (nitric acid).....	N^2O^5	108

From these compounds and their symbols we are led to the consideration of the second law of chemical combination. This runs as follows. If more than one compound of the same two elements is known, it is found that the number of atoms of one of these elements combined with a certain constant number of atoms of the other element, are multiples of unity. Thus in the five compounds of nitrogen and oxygen, if the number of nitrogen atoms, in proportion to two of the oxygen atoms be calculated, they are found respectively to be 1, 2, 3, 4, 5. No fractions of atoms occur.

Nitrogen oxide, or monoxide ; μονος (monos) = alone.

a. N^2O.
b. 44.
c. PREPARATION. From ammonium nitrate.

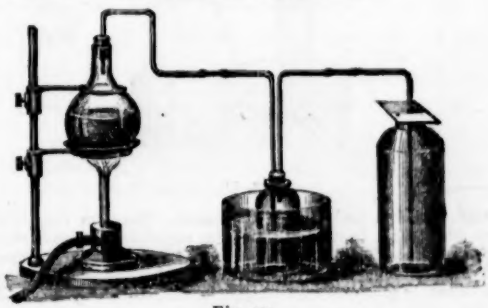


Fig. 30.

1. Neutralise the alkali ammonia with the acid hydrogen nitrate (nitric acid). Evaporate the liquid compound until the solid salt ammonium nitrate is deposited. Place this in a flask, as in Fig. 30, whose delivery-tube passes into an empty bottle standing in a pan of cold water. From the empty bottle a tube passes to a gas-jar. Heat the flask containing the ammonium nitrate. This salt melts, appears to boil, breaks up into steam, which is condensed in the empty bottle, and nitrogen oxide, which is caught in the gas-jar. The gas must be caught over *hot* water, not over cold, as it is soluble in water.

2. $H^2N + HNO^3 = H^4NNO^3 \ldots H^4NNO^3 = 2H^2O + N^2O$
3. 17 + 63 = 80 ... 80 = 36 + 44
2 vols.

d. 1. A gas tolerably easy to liquefy. A pressure of 30 atmospheres or a temperature of −88° turns the gas into a liquid.

2. With sweetish taste and odour; colourless.

3. 22 o $\frac{22}{14{\cdot}47}$

4. Tolerably soluble. 100 cc. of water take up 130 cc.

5. A supporter of combustion, but not combustible. Its power of supporting combustion is due to the fact that burning bodies decompose this gas into nitrogen and oxygen, and the latter gas when set free unites with the burning substance. The gas may be breathed without destruction of life.

6. In small quantities or mixed with air this gas acts as a stimulant, and especially to the muscular system. Hence its common name of 'laughing gas.' Breathed in an undiluted form it acts as an anæsthetic. *a* (a), the Greek privative, meaning 'without'; *αισθησις* (aisthesis) = feeling. It is used largely in dentistry, and minor operations.

A stock question at examinations is on the similarities and dissimilarities between oxygen and nitrogen oxide. These are best understood if the two gases are compared according to our plan.

1.	Oxygen is very difficult to liquefy.	Nitrogen oxide, comparatively easy.
2.	„ without taste or odour.	„ „ has both taste and odour.
3.	„ has specific gravity, 16.	„ „ sp. gr. 22.
4.	„ is little soluble in water.	„ „ is more soluble.
5.	„ supports combustion, leaving no nitrogen behind.	„ „ supports combustion, leaving nitrogen behind.
6.	„ is stimulant; not anæsthetic.	„ „ is first stimulant, then anæsthetic.
7.	„ gives the reaction with pyrogallic acid (page 155).	„ „ does not give the reaction with pyrogallic acid.

NITROGEN DIOXIDE.

a. NO.

b. 30.

c. Place in a bottle fitted with a thistle-funnel and a delivery-tube, Fig. 31, some copper turnings. Arrange the pneumatic

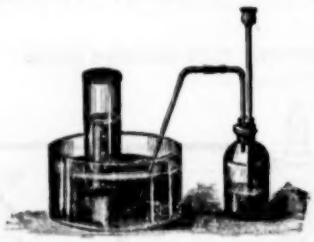


Fig. 31.

trough, beehive, and gas-jars, as usual. Pour on the copper pure nitric acid (not diluted). The metal is dissolved, and a green solution of copper nitrate is formed. A gas, at first densely red and fuming, but after all the air has been driven out colourless, is given off and caught in the customary way over water. Steam is formed at the same time.

2. $3Cu + 8HNO^3 = 3[Cu2(NO^3)] + 4H^2O + 2NO$
3. 189 + 504 = 561 + 72 + 60
4 vols.

The symbols of the reaction just given are rather difficult, and may with advantage be considered a little in detail. 3Cu is easy enough. $8HNO^3$ means 8 molecules of the compound hydrogen nitrate or nitric acid. In this the basylous radical is one atom of the monad element hydrogen. It is joined with one molecule of the compound radical NO^3, which is, therefore monovalent. But copper is a dyad metal. Therefore, 1 atom of copper replaces 2 atoms of hydrogen, and joins with 2 molecules of NO^3. The symbol for copper nitrate is $Cu2NO^3$; of this we have 3 molecules. Hence the 3 to the left in the formula $3[Cu2(NO^3)]$ multiplies everything within the square brackets, and the 2 multiplies everything within the curved brackets.

Suppose the symbols written down as far as $4H^2O$.

$$3Cu + 8HNO^3 = 3[Cu2(NO^3)] + 4H^2O.$$

Count up the number of atoms of each element on both sides of the equation thus far: 3Cu to the left, 3Cu to the right, 8H to the left, 8H to the right, 8N to the left, 6N to the right, 24O to the left, $3 \times 2 \times 3 = 18 + 4 = 22$O to the right; ∴ 2N and 2O remain on the left-hand side to be accounted for, and the writing of 2NO will effect this.

In a way similar to this, the student should practise the working out of equations, always taking care to assure himself that the symbols he works out are not merely the result of playing with the letters and numbers, but represent real facts.

SECOND PREPARATION.—From potassium nitrite.

1. Heat potassium nitrite with dilute sulphuric acid (hydrogen sulphate) in a flask, and catch the gas as in the preceding experiment.

d. 1. A gas very difficult to liquefy. Until the experiments of Pictet and Cailletet it was regarded as a permanent gas.

2. Without taste, odour, colour: transparent.

3. 30 or $\frac{30}{14{\cdot}47}$.

If the student refers to page 319, he will see that the list of compounds of nitrogen and oxygen might be written, so far as symbols are concerned N^2O, N^2O^2, N^2O^3, N^2O^4, N^2O^5, but that the second and fourth in this list are written NO and NO^2 respectively. Why are the latter symbols adopted, instead of N^2O^2 and N^2O^4? Because if they are adopted, the law of volumes in regard to compound gases given some page above, that the weight-number of every compound gas taken in grams at o° and under 760 mm. pressure measures 22·4 litres then holds good, while it is broken if the symbols N^2O^2, N^2O^4 are used. Thus in the case of nitrogen dioxide 22·4 litres of the gas at normal temperature and pressure are found to weigh 30 grams (N = 14, O = 16) not 60 grams.

This explanation also brings out the difference between an *empirical* and a *rational formula.* An empirical formula only tells the numerical ratio of the elements present in a compound, not how they are grouped exactly. It gives the percentage composition of the body. Thus NO, N^2O^2, N^3O^3, N^4O^4, N^nO^n would all be empirical formulæ for the gas in question. But the only rational formula is NO, as that states the precise composition of the molecule of nitrogen dioxide.

4. Very little soluble in water.

5. Not a supporter of combustion. Combustible. It unites very readily with oxygen to form a mixture of the next two higher oxides of nitrogen, the trioxide and the tetroxide. The dense red fumes noticed at the beginning of the experiment for its preparation are due to the gas joining with the oxygen of the air in the apparatus, and if a jar containing nitrogen dioxide is opened so that the air reaches it, similar fumes appear. This is a case of combustion without any flame at all. If a piece of phosphorus, burning feebly, is placed in the gas, the flame goes out. But a piece of phosphorus, burning brightly, continues to burn, as the heat given out decomposes the nitrogen dioxide, liberating oxygen, which unites with the phosphorus.

6. If the gas is passed into a solution of iron sulphate, $FeSO^4$, the greenish solution becomes black. This is of importance as explaining one of the tests for nitrates (see page 322).

NITROGEN TRIOXIDE.

a. N^2O^3.

b. 76.

c. 1. Combine the last-described compound of nitrogen and oxygen with the exact quantity of oxygen necessary for the formation of nitrogen trioxide only.

2. $4NO + O_2 = 2N^2O^3$.

3. 120 + 32 = 152.
8 vols. 2 vols. 4 vols.

d. 1. Gas. Easily liquefied.

2. Irritating odour, deep-red colour.

3. 38 or 38 ÷ 14·47.

4. Unites readily with water, forming the important acid compound, hydrogen nitrate or nitrous acid.

$$N^2O^3 + H^2O = 2HNO^2$$
$$76 + 18 = 94$$

This compound is the starting-point of all the metallic nitrites. If the hydrogen in it is replaced by various metals, we have salts of these metals.

HNO^2	hydrogen nitrite.
KNO^2	potassium ,,
$Cu2(NO^2)$	copper ,,

Tests for Nitrites.

The chemist has often to determine the nature of some solution submitted to him. For this purpose he has, as the result of a number of experiments, a set of tests, by the application of which he can tell what metals and what acids are present in a given solution. In this work only the tests for the acids present in salts will be considered.

In testing for acids, certain liquids known as reagents are mixed with the liquid to be investigated in test-tubes scrupulously cleaned by the aid of distilled water, and the results are noted. If we at once explain the tests for nitrites they will serve as a general example.

The student, in testing, should have a note book ruled off into four columns thus—the last column can only be filled in when the salt is known :—

Reagent.	Result.	Inference.	Symbols.
Nitrites.			

1. + barium chloride ($BaCl^2$). No precipitate.

$$2KNO^2 \textit{ e.g.}, + BaCl^2 = 2KCl + Ba(2NO^2).$$
$$170 \quad 208 \quad 149 \quad 229$$

Both of the salts formed are soluble.

2. + silver nitrate ($AgNO^3$). No precipitate.

$$KNO^2 \textit{ e.g.}, + AgNO^3 = KNO^3 + AgNO^2$$
$$85 \quad 170 \quad 101 \quad 154$$

Both these salts are soluble.

3. + dilute sulphuric acid (H^2SO^4). Brown fumes of nitrogen trioxide and tetroxide resulting from the union of oxygen with the nitrogen dioxide that is formed.

4. + iron sulphate ($FeSO_4$) and sulphuric acid (H^2SO^4) = brown colour, that becomes black, due to the formation of nitrogen dioxide and its solution in the iron sulphate.

NITROGEN TETROXIDE.

a. NO^2.

b. 46.

c. FIRST PREPARATION.—From lead nitrate.

1. Heat lead nitrate in a retort coated with clay. See Fig. 32. Plug the mouth of the retort with a loose piece of asbestos, and fit with a tube bent as in the figure. Surround the lower part of the bent-tube with powdered ice and salt. The lead nitrate melts, decomposes, gives off a mixture of oxygen and nitrogen tetroxide. The red vapour of the latter liquefies in the cooled part of the tube. When the latter is three-fourths full seal the drawn-out end with the blow-pipe, and remove the tube, replacing it by another until no more gas is given off. Lead oxide remains in the retort.

2. $2\,Pb(NO^3)^2 = 2PbO + O^2 + 4NO^2$.

3. 662 = 446 + 32 + 184.
2 vols. 8 vols.

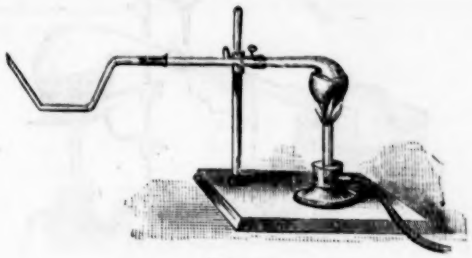


Fig. 32.

SECOND PREPARATION.—From air.

1. Pass electric sparks through air, and nitrogen tetroxide is formed.

d. 1. Liquid, freezing at −10°, boiling at 22°.

2. Yellow at ordinary temperatures, but at lower temperatures colourless.

3. Specific gravity as a liquid 1·451. As a gas its specific gravity varies with the temperature. Near the boiling point, 22°, its specific gravity is 46 as compared with hydrogen, corresponding with the formula N^2O^4. But at the higher temperatures the gas is 23 times as heavy as hydrogen under like conditions, corresponding with formula NO^2. Probably as the temperature rises each molecule splits into 2 molecules. This splitting up of a molecule is called dissociation.

4. Soluble in water, but undergoing decomposition as it dissolves. A mixture of the two acids, nitrous and nitric (hydrogen nitrite and hydrogen nitrate) is formed.

$$2(NO^2) + H_2O = HNO^2 + HNO^3$$
$$92 + 18 = 47 + 63.$$

NITROGEN PENTOXIDE.

a. N^2O^5.

b. 108.

c. 1. From silver nitrate and chlorine. If chlorine is passed over silver nitrate, silver chloride and nitrogen pentoxide are formed.

2. $4AgNO^3 + 2Cl_2 = 4AgCl + 2N^2O^5 + O^2$.

3. 680 + 142 = 574 + 216 + 32.
2 vols.

SECOND PREPARATION.—From hydrogen nitrite and phosphorus pentoxide.

1. Slowly distil pure nitric acid at a temperature of 35° with phosphorus pentoxide. The latter takes up water and liberates nitrogen pentoxide. The distillate consists of two layers of liquid. Draw off and cool the upper and the nitrogen pent oxide separates in crystals.

2. $6HNO^3 + P^2O^5 = 2H_3PO^4 + 3N^2O^5$.
$378 + 142 = 196 + 324$.

a. 1. Solid: crystalline, taking the form of six-sided prisms; melting point, 30°.

2. Without odour, taste, or colour.

3. 1·64 as a solid. 1·636 as a liquid. 54 or $\frac{54}{14{\cdot}47}$ as a gas.

4. Dissolves in water with great evolution of heat and formation of hydrogen nitrate or nitric acid.

$$N^2O^5 + H^2O = 2HNO^3.$$
$$108 + 18 = 126.$$

This derivative of nitrogen pentoxide is the most important compound of nitrogen, and will be considered at length.

HYDROGEN NITRATE, OR NITRIC ACID.

a. HNO^3.

b. 63.

c. PREPARATION. From potassium nitrate and sulphuric acid.

1. Take a retort and fill the bulb about one-third full of nitre. Arrange the retort as shown in Fig. 33 with moistened blotting

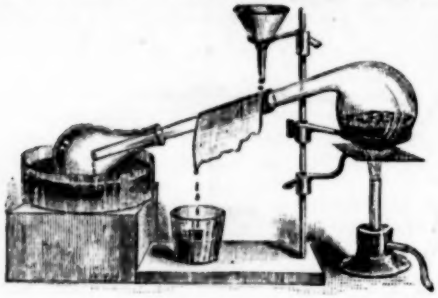


Fig. 33

paper on the neck and the mouth of the tube passing into a bottle surrounded by cold water. Heat the retort. Potassium sulphate, or potassium hydrogen sulphate, and hydrogen nitrate, are formed, and the latter distils over into the flask, where it is condensed.

2. This reaction may be represented in two ways, according to the quantities of the two materials that are taken.

$$\alpha.\ 2KNO^3 + H^2SO^4 = 2HNO^3 + K^2SO^4.$$
$$202 + 98 = 126 + 174.$$

$$\beta.\ KNO^3 + H^2SO^4 = HNO^3 + KHSO^4.$$
$$101 + 98 = 63 + 136.$$

If the student studies these two sets of symbols he will see that the same quantity of sulphuric acid (the expensive one of the two substances used) is employed in each case, and that in α twice as much nitric acid is formed as in β. Clearly, therefore, α represents a more economical way of preparing nitric acid. It gives, indeed, the symbols of the manufacturing method. On the other hand, the salt represented by K^2SO^4 is less solid than the salt represented by $KHSO^4$, and is, therefore, more difficult to remove from the apparatus after the experiment. Hence, in laboratories, where expense is less a question than convenience, the two substances are taken in the proportions represented by the second equation. This equation therefore represents the laboratory method.

d. 1. Liquid, boiling at 84°. When it boils nitric acid breaks up partly into oxygen, water, nitrogen tetroxide.

2. Sour taste, irritating odour, colourless if pure.

3. 1·52 as a liquid.

4. Mixes readily with water. Its great affinity for water makes it fume in air, as it takes the moisture from the air.

5. Not combustible. If heated, as by dropping it into the bowl of a clay pipe whose stem is strongly heated, it decomposes into oxygen, nitrogen tetroxide, and water.

6. Acid.

Exposed to light it decomposes partly into oxygen, water, nitrogen tetroxide.

Nitric acid is a great oxidiser. From the readiness with which it decomposes, it is very apt to furnish oxygen to bodies with which it is brought into relation. Thus, if the acid is dropped on red-hot charcoal, carbon dioxide is formed. If it is boiled with some flowers of sulphur in a test-tube, hydrogen sulphate, sulphuric acid, is formed.

Its action on metals is as a rule to dissolve them. This is only a special case of oxidation. Whenever the metal is thus dissolved a nitrate of it is formed. The other products vary with the nature of the metal and the strength of the acid; the symbols of its action on tin, silver, copper, zinc, follow.

On iron, gold, platinum, its action is nil.

On tin. $Sn + 4HNO^3 = Sn2(NO^3) + 2NO^2 + 2H^2O$
stannous nitrate
$118 + 252 = 242 + 92 + 36$. Nitrogen tetroxide is formed.

On silver. $4Ag + 6HNO^3 = 4AgNO^3 + 3H^2O + N^2O^3$
$432 + 378 = 680 + 54 + 76$. Nitrogen tetroxide is formed.

On copper. $3Cu + 8HNO^3 = 3[Cu2(NO^3)] + 4H^2O + 2NO.$
$189 + 504 = 561 + 72 + 60.$
4 vols.
Nitrogen dioxide is formed.

On zinc. $4Zn + 10HNO^3 = 4[Zn2(NO^3)] + 5H^2O + N^2O$
$260 + 630 = 756 + 90 + 44$
2 vols.
Nitrogen monoxide is formed.

The nitrates are salts in which the hydrogen of hydrogen nitrate is replaced by some metal. Examples of nitrates with monad, dyad, triad, tetrad metals follow.

Hydrogen nitrate		HNO^3
Potassium	,,	KNO^3
Mercury	,, (mercurous form)	$HgNO^3$
Copper	,,	$Cu^2(NO^3)$
Mercury	,, (mercuric form)	$Hg2(NO_3)$
Tin	,, (stannous form)	Sn^2NO^3
Bismuth	,,	$Bi3(NO^3)$
Tin	,, (stannic form)	$Sn4(NO^3)$

The second of these, potassium nitrate, is one of the constituents of the mixture, gunpowder. The other two constituents are charcoal and sulphur. If nitre (potassium nitrate), sulphur, and charcoal are mixed, and set on fire, an explosion takes place, as the gases formed occupy many times the volume of the original mixture.

Tests for Nitrates.

1. $+BaCl^2$ = no precipitate
$2NaNO^3$ (*e.g.*) $+ BaCl^2 = Ba2NO^3 + 2NaCl.$
Both salts are soluble.
1. $70 + 208 = 261 + 117.$

2. $+AgNO^3$ = no result. The two nitrates are unchanged.

3. $+H^2SO^4 + Cu$ = red gas and green liquid. The hydrogen sulphate liberates hydrogen nitrate, and this acts on the copper as in the preparation of nitrogen dioxide. The green solution is copper nitrate. The red gas is a mixture of nitrogen trioxide and nitrogen tetroxide, formed by the oxidation of nitrogen dioxide.

KNO^3 (*e.g.*) $+ H^2SO^4 = KHSO^4 + HNO^3$
$101 + 98 = 136 + 63$
$3Cu + 8HNO^3 = 3[Cu2(NO^3)] + 4H^2O + 2NO.$
$189 + 504 = 561 + 72 + 60$
4 vols.

4. $+H^2SO^4$ and (after cooling by immersion of the test-tube in cold water) $FeSO^4$ = brown ring where the solution of the $FeSO^4$ rests on the other liquids. The ring is due to the solution in the $FeSO^4$ solution of lower oxides of nitrogen.

EXERCISES ON THE OXIDES OF NITROGEN (*solved*).

84. Under what pressure (the temperature being normal) will 12 litres of nitrogen oxide be given off from 40 grams of ammonium nitrate?

80 grams $H^4N^2O^3$ give off 22·4 litres N^2O at normal.
1 gram ,, gives ,, $\frac{22{\cdot}4}{80}$,, ,, ,,
40 grams ,, give ,, $\frac{22{\cdot}4 \times 40}{80} = 11{\cdot}2$,,
11·2 under pressure 760 mm.
1 ,, $760 \times 11{\cdot}2$,,
12 ,, $\frac{760 \times 11{\cdot}2}{12} = 709\frac{1}{3}$ mm.

85. On 207 grams of copper 500 cc. of nitric acid of specific gravity 1·5 are poured. How much of which of the two substances used is in excess?

189 grams Cu need 504 grams HNO^3
1 gram ,, needs $\frac{504}{189}$,, ,,
207 grams ,, need $\frac{504 \times 207}{189} = 552$ grams.
At specific gravity 1,500 cc. weigh 500 grams.
,, ,, 1·5 ,, ,, $500 \times \frac{1}{3} = 750$
$\therefore$ 750 − 552 = 198 grams of nitric acid are in excess.

86. Find the volume of air necessary for the conversion of 700 cc. of nitrogen dioxide into nitrogen trioxide.

4 vols. NO need 2 vols. O.
1 vol. ,, needs $\frac{1}{2}$,, ,,
700 vols. ,, need $\frac{2\times700}{4}$,, ,, =350 vols.

1 vol. oxygen exists in 5 vols. air.
350 vols. ,, exist ,, $5\times350=1750$ vols. $=1750\times11{\cdot}2$
$=19{,}600$ litres.

87. Find the percentage composition of nitrogen tetroxide. NO^2 is the symbol.

$\therefore$ $14+32$
$=46$ parts by weight of NO^2 contain 14 of N & 32 of O.
1 part ,, ,, contains $\frac{14}{46}$,, $\frac{32}{46}$,,
100 parts ,, ,, contain $\frac{14\times100}{46}$,, $\frac{32\times100}{46}$,,
$30\frac{4}{23}$N. $69\frac{19}{23}$O.

88. How much nitric acid of specific gravity 1·5 is necessary for the complete solution of 540 grams of silver?

432 grams Ag need 378 grams HNO^3.
1 gram ,, needs $\frac{378}{432}$,, ,,
540 grams ,, need $\frac{378\times540}{432}$,, ,,

$\frac{378\times540}{432}$ grams of specific gravity 1, occupy $\frac{378\times540}{432}$ cc.
,, ,, ,, $1\frac{1}{2}$, ,, $\frac{378\times540}{432}\times\frac{2}{3}$
$=315$cc.

EXAMPLES ON THE OXIDES OF NITROGEN.

(*For solution.*)

77. What is the temperature if, when the pressure is 800 mm. 16 grams of ammonium nitrate give off $4\frac{4}{5}$ litres nitrogen oxide? .....27°.

78. Find the percentage composition of nitrogen dioxide. .....N $46\frac{2}{3}$. O $53\frac{1}{3}$.

79. What volume of nitrogen trioxide is necessary to produce, when combined with water, 47 grams of nitrous acid (hydrogen nitrite)..... ....11·2 litres.

80. If the volume of nitrogen tetroxide and oxygen given off by heating of lead nitrate at a temperature of 117° is 160 litres, what weight of the nitrate has been decomposed? ...662 grams.

81. 202 grams of nitre are required. What volume of nitric acid of specific gravity 1·5 must be taken to form them?...84 cc.

(*To be continued.*)

—o—

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Schmitz's Latin Grammar.
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Address, 'A. B.,' Office of PRACTICAL TEACHER.

Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.

(1)	(2)	(3)
697	806	907
680	97	578
59		
708	709	329
15		
2159		

STANDARD II.

(1)	(2)
89,990	From 87,608
8,079	Take 9,570
687	
53,700	78,038
90,896	
7,689	
251,041	(4) 47,968
	708
(3)	383,744
9)41,385	3,357,760
4,598$\frac{4}{9}$	33,961,344

STANDARD III.

(1) Multiply eighty-nine thousand seven hundred and forty-six by seven hundred and nine.
Ans. 63,629,914.

(2) Add eight pounds seventeen shillings and ninepence halfpenny, thirteen shillings and elevenpence, seventy-four pounds sixteen shillings and sixpence farthing, one hundred and eight pounds and tenpence three farthings, and fifteen shillings and eightpence three farthings. Ans. £193 4s. 10¼d.

(3) £100,784 13s. 3½d. – £904 14s. 11d.
Ans. £99,879 18s. 4½d.

(4) If I spend 2s. 8d. for sugar, 4s. for butter, and as much for tea as for sugar and butter together, how much do I spend in all?
Ans. 13s. 4d.

STANDARD IV. (GIRLS.)

Time allowed—45 *minutes.*

(1) Multiply £49 13s. 0½d. by 52.
Ans. £2581 18s. 2d.

(2) How many ozs. are there in 2 tons 8 cwt. 1 st. 15 ozs? Ans. 86,255 ozs.

(3) Reduce 24,050 yards to miles, furs., poles, and yards.

24050 yds.
2
11 | 48100 half yds.
40 | 4372 poles 4 yds.
8 | 109 fur. 12 poles 4 yds.
13 m. 5 fur. 12 poles. 4 yds. Ans.

(4) If it takes 40 yards of calico at 9½d. per yard to make a dozen shirts, find the cost of calico for one shirt.

9½d. × 40 = £1 11s. 8d. price of 1 dozen.
£1 11s. 8d. ÷ 12 = 2s. 7⅔d. price of 1 shirt.

STANDARD IV. (BOYS.)

(1) Reduce a million seconds to weeks.

Ans. 1 wk. 4 dys. 13 hrs. 46 min. 40 sec.

(2) Reduce 51 sq. yds. 0 ft. 68 in. to inches.

Ans. 66,164 inches.

(3) Multiply £687 17s. 4½d. by 479.

Ans. £329,489 2s. 7½d.

(4) A man had his pocket picked of 3s. 4d. If the thief had taken 6s. 8d. more he would have taken half the person's money. How much had he at first?

2(3s. 4d. + 6s. 8d.) = 20s. Ans.

STANDARD V.

(1) Find by Practice the value of 9 tons 13 cwt. 21 lbs. at £5 6s. 8d. per ton.

	£	s.	d.		
10 cwt. = ½ ton	5	6	8	value of 1 ton	
			9		
	48	0	0	„	9 tons.
2 cwt. = ⅕ of 10 c.	2	13	4	„	10 cwt.
1 cwt. = ½ of 2 c.		10	8	„	2 „
14 lbs. = 1/8 of 1 c.		5	4	„	1 „
7 lbs. = ½ of 14 lbs.			8	„	14 lbs.
			4	„	7 „
Ans.	£51	10	4	„	9tn. 13c. 21lbs.

(2) Add $(\frac{2}{3} - \frac{1}{4})$ to $(\frac{2}{4} + \frac{2}{5})$
$(\frac{2}{3} - \frac{4}{5}) + (\frac{3}{5} + \frac{3}{5})$
$\frac{1}{6} + \frac{5}{5} = 1$. Ans.

(3) How many men can finish a piece of work in 5 days, when 5 men can complete the same in 24 days?

5 days : 24 days :: 5 men : 24 men. Ans.

(4) Make out the following bill :—

	£	s.	d.
4 Hearthrugs at 16s. 4d. each	3	5	4
19 yds. carpet at 3s. 6d. per yard	3	6	6
A table at 17s. 6d.	0	17	6
21 yds. carpet at 2s. 8d. per yard	2	16	0
15 brass rods at 14s. 6d. per doz.	0	18	1½
A sofa at 47s. 6d.	2	7	6
Ans.	£13	10	11½

STANDARD VI.

(1) What fraction of £9 is ½ of $\frac{9}{10}$ of 2s. 6d.?

$\frac{\frac{1}{2} \times \frac{9}{10} \times \frac{5}{2}}{180} = \frac{1}{2} \times \frac{9}{10} \times \frac{5}{2} \times \frac{1}{180} = \frac{1}{160}$. Ans.

(2) Multiply (2·675 ÷ ·02675) by ·0125.

Ans. 1·25.

(3) If in the time an ordinary train travels 5 miles, an express train travels 7 miles, how many miles apart would the two trains be when the express has travelled 127½ miles if both were travelling in the same direction?

7 : 5 :: 127½ : $91\frac{1}{14}$
$127\frac{1}{2} - 91\frac{1}{14} = 35\frac{3}{7}$. Ans.

(4) In what time will £1275 amount to £1549 11s. at 3⅜ per cent.?

£1549 11/20 − £1275 = £274 11/20
(1275 × 3⅜) ÷ 100 = £48 9/20
274 11/20 ÷ 48 9/20 = 5⅔ years. Ans.

STANDARD VII.

(1) Find the simple interest on £1260 from May 16th to July 28th at 3½ per cent. per annum.

£
(1260 × 3½) ÷ 100 = £44 2s.
May 16th to July 28th = 73 days = ⅕ year.
⅕ of £44 2s. = £8 16s. 4·8d. Ans.

(2) If 3 guineas is charged for the carriage of 4 cwt. for 120 miles, what weight can be carried 110 miles for 2 guineas?

	cwt.		cwt.
miles 110	: 120 ::	4	: 2 10/11. Ans.
guin. 3	: 2		

(3) I sold a horse at 48 guineas, thereby gaining 12 per cent. What did it cost me?

	£ s.		£
112	: 100 ::	50 8	: 45. Ans.

(4) One third of a haystack is sold for £42, one half for £52 10s., and the remaining 36 cwts. at 9s. per cwt. What is the average price per cwt.?

⅓ + ½ = 5/6 ∴ 36 cwt. = ⅙.
∴ ½ = 108 cwt. and ⅓ = 72 cwt.
72 cwts. sell for £42 0s.
108 „ „ £52 10s.
36 „ at 9s. £16 4s.
216 cwts. sell for £110 14s.
∴ 1 cwt. sells for 10s. 3d. Ans.

Dictation.

Standard I.—House, water, field, spring, trees, mother, father, milk, book, bread.

Standard II.—'Royal Reader,' No. 2, page 54:
'In spring . . . . from his fat.'

Standard III.—'Royal Reader,' No. 3, page 158:
'They cast lots . . . . little bread.'

Standard IV.—'Royal Reader,' No. 4, page 130:
'And now she resolves . . . . snowy drift.'

Grammar.

Standard III.—(1) Pick out the parts of speech from these words:—'They were always very good children, for they never forgot to do their lessons.'

(2) Put pronouns in the following:—'John will get on for . . . . always does . . . . very best.'

(3) Make sense of the following words:—The rain heavy week last spoiled has crops our wheat.

Standard IV.—(1) Parse: 'I saw him distinctly as he struggled on through the angry waves.'

(2) What is a pronoun? a preposition?

(3) Write a sentence containing a conjunction and an adverb.

(4) 'I met a little cottage girl;
She was eight years old, she said.'

How can you tell that 'met' is a verb, and 'eight' is a numeral adjective?

Standard V.—(1) Analyse:—

'The sun shines in beauty,
O'er mountain and river;'

or, 'They always did their lessons well.'

(2) Parse the sentence you analyse.

(3) Form verbs from the words—strength, knee, glass, song, bath.

Standard VI.—(1) Analyse 'The ship glided into the water when the last support was taken away.'

(2) Parse it.

(3) Give the meaning of the words pronoun, adverb, preposition, conjunction, and interjection. Pick out the prefix and give the meaning.

Recitation.

The following recitations were accepted in Standards I. to VII., respectively:—'Mary had a little lamb,' 'The Beggar-man,' 'The Inchcape Bell,' 'Bethgelert,' Selection from 'Marmion,' Selection from 'King John.'

—o—

Science Notes.

PURIFICATION OF WATER.—The removal of minute organisms from water is very important in its bearings on public health. These minute forms are often the evidence, and the result of organic pollution. They are sometimes capable of producing the most serious disorders. A ready and sure method of removing them would be of the utmost practical value. It is satisfactory to learn that scientific men are working at this problem seriously. A paper by Percy F. Frankland, Ph.D., on the removal of micro-organisms from water, has recently been read at the Royal Society. It states, that when water is filtered through six inches of green sand, silver sand, coke, or spongy iron, all the animal forms were removed. After being some time in use it is found that spongy iron and coke were still capable of very greatly reducing the number of living forms, though not of removing them entirely; spongy iron allowed scarcely any to pass through. It is further found, that the agitation of water with spongy iron, or, better still, with finely divided coke, has the effect of leaving the liquid nearly free when the solid particles have subsided. Again, when water is submitted to Clark's well-known process for softening it on a large scale, it becomes softer and purer at the same time, the organisms being very largely diminished. It is plain, therefore, that there are various simple processes for removing objectionable forms from water. It is equally plain that the merits of gas-coke and spongy iron, especially the latter, are confirmed by the latest investigations. Meantime, and without waiting for new processes or simpler and cheaper apparatus, let us remember that water can be made almost perfectly safe by boiling it well. When cold, such water is insipid. This can be remedied by charging it with CO_2 in an ordinary gasogene. Failing that, it can be filtered through a block of gas-carbon, or through a thick layer of green or silver sand. The great point for most people to remember is, that water and milk too that have been boiled are practically safe.

***

TELEPHONES.—Telephones are coming into use much more rapidly than could be anticipated, when it is remembered that it costs £20 to have one set up. This monopoly price is not likely to be long maintained, as rival companies are in the field. It is proposed to put up the 'Mechanical Telephone' for three pounds, and a small annual charge for keeping it in repair. The 'Mechanical Telephone' needs no battery, and is said to be very efficient. We may, therefore, expect to see a greatly extended use of these wonderful instruments. We have hardly begun to learn the value of the new power science has put into our hands. In a few years' time we shall be surprised how we could have got on without it.

***

GEOGRAPHY.—We are promised a new set of Geographical Text Books by eminent men. That is good news. It is also stated that there is a chance that the teaching of geography will thereby be put upon a proper scientific basis. Only a remote chance, as teachers very well know. At present we are told that geography is made a task for the memory rather than an instrument of education. To some extent, no doubt this is true. Is it not true of many other subjects? And if examiners keep asking the same sort of questions as they do now, will a new set of text books effect a revolution in the methods of study? Suppose a teacher says, My pupils studied this subject as an instrument of education; it is true, they had not acquired such a mass of information as was necessary to answer the examiner's questions, and they nearly all failed; but I am bound to say the teaching had been excellent. What would be the reply of managers, committees, and governors? Teachers who understand their work are getting tired of the nonsense that is so often heard. They are made do one thing, and blamed for not doing another. What with examinations, inspectors, and managers, a teacher's independence and individuality are seriously endangered. If we were asked what would do most to promote the study of geography, we should say, the multiplication of such objects and appliances other than books as trained and enthusiastic teachers find it necessary to use. Under present circumstances books are indispensable, but let us not go about saying that teachers dont know how to teach geography, or that any great change will take place from the issue of a new set of Text Books.

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INVENTORIES.—Those of our readers who want to get instruction as well as amusement will do well to consult the official catalogue. No one is specially interested in many subjects. Having made a selection, the visitor should read the essays which have been written with the view of noting the most important inventions of the last quarter of a century. There are thirty-one groups, and to most of them a short but valuable summary is attached, many of them being written by very eminent men. The

visitor is thus enabled to watch the development of invention during the last quarter of a century. Professor Harcourt, for instance (Group 15), tells us that there has been improvement in nearly every stage of gas manufacture; in heating the retorts, in recovery of heat before wasted, in better use of the old methods of purifying, and in making a useful gas from steam and anthracite coal. Meters and burners are improved. Attention has been given to the extraction of paraffin from petroleum, and is now fixed on better methods of separating the fatty acid from the natural fats. Lamps are now constructed so that a powerful illumination is obtained from two or more intracting flames. Such is an abstract of the essay 'Gas and other Illuminants.' It will be seen at once how helpful they will be to those who are really intent on learning all they can from the Exhibition of 1885.

***

RAINFALL.—We are not accustomed to tropical rainfalls in this country. There has been no such downpour within memory of the present generation as fell on the upper Dee-side on the 12th of August. At Castletown Observatory the rain-gauge registered 3·44 inches in less than twelve hours. When we remember that 28 inches is a fair rainfall for a year, the extraordinary nature of the storm becomes evident. Our young readers may be interested in expressing the weight of water in tons per acre. As a cubic foot of water weighs about 62·4 lbs., one inch of rainfall would be $\frac{62{\cdot}4}{12}$, or 5·2 lbs. per square foot. This would be

$$\frac{62{\cdot}4}{12} \times \frac{9 \times 4840}{28 \times 4 \times 20} = 101 \text{ tons per square acre.}$$

The rainfall at Castletown was therefore = 353 tons per acre.

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BRITISH ASSOCIATION.—The meeting of the British Association is to be held this year at Aberdeen. The first meeting is fixed for September the 9th. Arrangements are being made to ensure successful work being done in the various sections. In the chemical section, under the presidency of Dr. Armstrong, there will be a discussion on the determination of the molecular weights of solid and liquid bodies. Papers will be read giving what is at present known on the subject, and indicating the directions in which further investigation is needed, and how it may be carried on. Captain Abney, Professors Guthrie, Reinold, Tilden, Armstrong, and Russell will contribute papers. Another subject for consideration will be Electrolysis, in which Professor Schuster, Captain Abney, Mr. Bedwell, and others will take part. In the section on Physics there will be discussions of the Kinetic theory of gases, and on standards of white light. Professor Crum-Brown has consented to open the discussion, and has already indicated that he means to call attention to some discrepancies between the conclusions derived from the dynamical theory and observed facts, in the hope that they may be removed, possibly in showing that the facts have not been correctly observed, or that the conclusions have not been legitimately drawn from the theory. A few of the most important results of these discussions will appear in these pages in due course.

How I Teach Domestic Economy.

BY MRS. WIGLEY.

Author of 'Marshfield Maidens,' 'Our Home Work,' 'Workers at Home,' 'Royal Series Domestic Economy,' 'Cookery and Home Comforts,' 'The Merryweathers,' 'Thoughts,' etc.

CHAPTER VII.

FOOD AND PHYSIOLOGY.

'JUST so much of the subject as will be necessary,' I said. It is my privilege in these papers to collect the material, which you will wish to present to your children, and place it ready to your hand—to select from a wide and complicated subject only so much of the information as will be needed. But I know that such information will seem to be meagre to those who are lovers of the subject, just because it is so wide and complicated. Still, with so much to take up in the year, as we have to take up concerning Domestic Economy, we must keep ourselves well within bounds with regard to all other matters, however tempting may be the fields which open up on either hand.

Here, then, is a brief summary of the physiological information our girls ought to have before we go further.

Our bodies are nourished and supported by the food we eat. *Every part* of the body needs to be so nourished. It is a common thing to put the food into the mouth, and not trouble ourselves further as to its work. Few of us stay to consider how it really goes to the bones, and hair, and nails, and flesh, and keeps in repair parts so utterly different from each other.

Before the body can make use of any kind of food, such food must be reduced to a liquefied state.

The whole process of reducing and appropriating food is called *digestion*, and is the work of the digestive organs. Food is reduced to a liquefied state by the action of alkalies and acids, which are secreted or stored up in various parts of the body by wonderful little organs called 'glands.' Glands are bunches of little cells and tubes, which are placed in various parts of the body for the purpose of forming fluids, which they store up or secrete, and then pour out on the food at the proper time.

We have six of these glands in the mouth, called the Salivary glands. We have others in the stomach and in the intestines, and they perform a very wonderful work for us.

Directly the food is put into the mouth the work of digestion begins.

The teeth tear and pulp, and cut and grind.

The glands pour out their moisture, and their combined fluids we call Saliva.

The saliva is composed of alkalies. These have the power of changing the nature of some of our food. All our food that is made from grain plants, such as wheat and rice, and also potatoes, are made of floury or starchy matter. Now, you know starch and flour will not mix with water and make a liquid, unless we boil it; it always sinks to the bottom if we leave off stirring it. What are we to do with the starch in our food then? It is of no use to us unless it will dissolve in the fluids which have to float it through our veins. This is how it is served. The saliva acts upon the starch and turns it into a kind of sugar, and then it

readily dissolves. Saliva does not act upon meat and fat in this way—only on the starch; it moistens the other, and forms it into a paste, but does not change it.

When the food is reduced to a pulpy mass by the teeth and the saliva, it is rolled into a ball by the tongue, and passed down a tube behind the windpipe, which is called the Œsophagus or the gullet, which leads to the stomach.

The Stomach is a bag or pouch—very like the bag of the bag-pipes; one end is much smaller than the other. The food enters by the œsophagus at the largest end, and leaves by the smallest end, which is joined to the bowels.

While the food is in the stomach it is further reduced. It is worked about, and all the while a great number of little tubes are pouring moisture on to it to make it more liquid; and this moisture acts upon the meat and dissolves it, and forms the whole of the food into a grey liquid, which is called Chyme. The moisture which is poured upon the food in the stomach is called the 'Gastric Juice.' It is a very strong acid, and the little tubes store up a great deal. A great many pints are poured into the stomach in twenty-four hours.

Now, we have seen that the starch foods are reduced in the mouth, and the other foods in the stomach, all except the fat.

When the stomach has done its work, the food is sent out through the smallest end into the beginning of the intestines. Here it receives a fluid from the liver, which dissolves the fat, and makes it mix thoroughly with the rest of the food.

Then the food passes slowly through the intestines, getting more and more fluid to make it thinner, until it looks something like milk, and is called '*chyle.*'

All over the inside of the intestines there are little tubes with mouths. These are very, very small, and are joined at the outside to other little tubes, which lead to larger and yet larger ones until they all meet together in a large tube or passage, which leads up to the large vein at the left side of the neck.

Now, when the food is ready, that is, when it has been formed into the milky chyle, the little mouths all over the intestines, which are called 'villi,' begin to suck it up, and pass it to the little tubes behind, and it is taken along the smaller to the larger up to the great vein by the neck, and is emptied into the great vein to be carried with the blood to every part of the body.

EXTRACT FOR DICTATION LESSONS.

Dr. Edwards thus speaks about the way in which the food is carried to every part of the body:—

'Along on the lines of these tubes and canals through which the blood, with all its treasures, flows, God has provided a vast multitude of little organs or waiters, whose office is each one to take out of the blood, as it comes along, that kind and that quantity of nourishment which it needs for its own support, and for the support of that part of the body which is committed to its care; and although exceedingly minute and delicate, they are endowed by their Creator with the wonderful power of doing this, and also of abstaining from and throwing back into the common mass that which is unsuitable, or which they do not want, to be carried to some other place where it is needed.

'For instance, the organs placed at the ends of the fingers, when the blood comes there, take out of it what they need for their support, and also what is needed to make finger-nails, while they will cautiously abstain from and repel that which will only make hair, and let it go on to the head. And the organs on the head carefully take out that which they need to keep the hair growing, and refuse that which is only good to make eyeballs, and let it go on to the eyes, and so on throughout the whole.'

Notes of a Lesson on the Formation of Valleys and Hills.

BY JOS. H. COWHAM, F.G.S.,
Westminster Training College.

ARRANGEMENT OF INFORMATION.

1. Contrast between Hilly and Plain Districts.
   - (*a*) Lincolnshire, in the south-east, is almost a dead level. It forms an extension northward of the Bedford level. This district is called the 'Fens.'
   - (*b*) In the centre and west, Lincolnshire is hilly. The Wolds in the north-central district, and the cliff range in the west, with the valleys between the hill ranges, make this part of Lincolnshire very uneven or '*undulating.*'
   - (*c*) In other counties similar contrasts may be formed, *e.g.*,
     - (1) The Cheshire plain with the hilly flanks of the Pennine chain.
     - (2) The plain of Holderness and the York Wolds.
     - (3) The Vale of York with the Cleveland hills on the E. and the 'dale district' on the W.

ILLUSTRATIONS, Etc.

(*a*) Teach by means of sketch map (Fig. 1).

Use also a roughly constructed sand model of Lincolnshire.

If the sand be slightly moistened it can very readily be worked into a good representation of hill and valley structure.

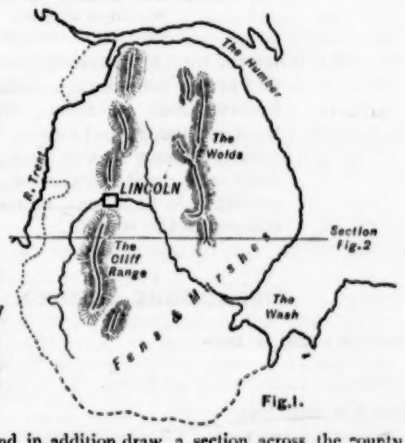

Fig.1.

(*b*) Use the model, and in addition draw a section across the county from east to west (Fig. 2).

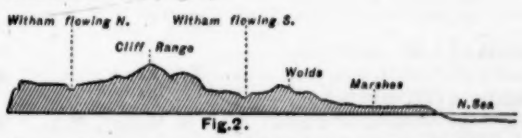

Fig.2.

(*c*) Point out the position of each district on the map of England

2. How Valleys are Formed.

(*Observations which children should be led to make.*)

(*a*) Water falling as rain on a nearly level area soon forms hollows in which it collects. After a heavy shower it flows over the surface in little watercourses termed *runnels.*

(*a*) Direct attention to the playground after a heavy shower, the watercourses are distinctly visible.

Roads and streets are constructed with slopes towards the sides, to prevent the water running in long streams in the direction of the road. The short stream from the crown to the sides of the road never gathers sufficient water to wear out great hollows.

(*b*) Succeeding showers fall, and the water rushes along the runnels, carrying away the loose sand and mud on the sides and bed, thus deepening the channel.

(*b*) Illustrate by means of the following diagrams.

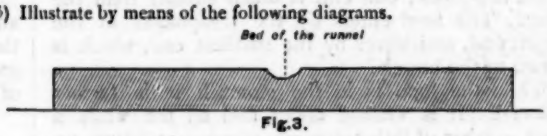

Fig.3.

Fig. 3. The runnel when first formed on almost level land.

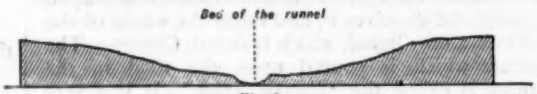

Fig.4.

Fig. 4. The runnel deepening its bed and widening its valley.

(*c*) If this work of running water is allowed to continue the runnel gradually widens and deepens until the area which was almost level becomes very uneven. A valley, or a series of valleys, with intervening high land is the result.

(*c*) A model composed of moistened sand, with a surface almost flat, should be now used. Gradually take away sand along certain lines, and allow the class to help in modelling out the series of valleys and hills.

3. What becomes of the material removed by the runnel.

(*a*) The muddy appearance of the water shows that the small particles of soil are being carried from high to low levels.

(*a*) This is further seen after the water has evaporated leaving a thick, muddy deposit in the hollows by the roadside.

(*b*) Larger particles which the water is unable to float are pushed along the bed of the stream.

N.B.—This work is greater than we often suppose. It is done out of our sight.

(*b*) Pebbles and small marbles sometimes may be thus rolled along by a small stream.

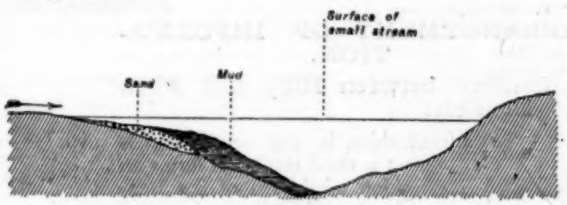

Fig.5.

Fig. 5. Deposit of sand and mud brought down by a small stream and deposited in a larger one. The runnel enters in the direction of the arrow.

(*c*) When the muddy materials reach the end of the runnel they collect in hollows and fill them; should, however, the runnel enter a larger stream flowing slowly along, then the mud and sand sink, and gradually form a bank of mud at the end of the runnel.

Publications Received.

Bell (G) and Sons—
Sir Roger De Coverley, etc. Selected by W. N. New.
Selections from the Arabian Nights. By G. C. Baskett.

Blackie and Son—
A Practical Arithmetic. By John Jackson.
Commentaries for Bible-classes. By T. M. Lindsay, D.D.
The Gospel of St. Mark.
The Acts of the Apostles. Parts 1 and 2.

Cassell and Co., Limited—
Cassell's Natural History Wall Sheets. Nos. 1 to 10.

Chambers (W. and R.)—
Key to the Elements of Euclid. By J. S. Mackay, M.A., F.R.S.E.

Heywood (John)—
The Scholar's History of England.
Answers to the Paragon Arithmetical Papers. Standards I. to VII.

Longmans and Co.—
Chouans et Bleus. By Paul Féval. Edited by Charles Sankey.
600 Questions in Geography, set to Civil Service Candidates. Edited by R. Johnston, F.R.G.S.

Philip (G.) and Son—
'English' Practice in Analysis, etc. By J. L. Richardson.
A Class-Book of Modern Geography. By W. Hughes, F.R.G.S.

Smith, Elder and Co.—
The Cornhill Magazine. August.

The Wesleyan Methodist Sunday-School Union—
Sunday-School Buildings.

Publications Reviewed.

Heat and Sound. By Richard Wormell, D.Sc., M.A. High School Science Series. London: Thomas Murby.

Some time since we had the pleasure of reviewing Dr. Wormell's very excellent little book on electricity and magnetism. The word 'pleasure' in the preceding sentence is no euphemism. We did actually experience delight in reading one of the best books of its kind we ever saw; and how rare such an experience is reviewers alone know. The work by the same author now before us is, after the other, a severe disappointment. It is like reading Bunyan's 'Holy War' after his 'Pilgrim's Progress,' and Dr. Wormell will understand thoroughly what is meant by that. Of course, this book on 'Heat and Sound' is handicapped unfavourably by comparison with its excellent predecessor. But it is really so far behind that predecessor that, although it is from the same hand, it really seems as if it were not from the same head.

Eight lectures (80 pages) are devoted to 'Heat'; eleven lectures (108 pages) to 'Sound.' In this disproportion the relative liking and disliking of the author seems to speak out; for almost all of the weaknesses of the work are in the part of it dealing with the subject to which the less attention has been given. In fact, the 'Sound' portion is very well done indeed. In the 'Heat' lectures are the shortcomings. Before dealing with these we note the absence of an index, and the rather inconsistent way in which physically historic names are mentioned or not mentioned. Thus, on page 10, Gravesande's ring is described anonymously, whilst on page 35, Ingenhous is mentioned. Derivations are not always given, or are given too late in the book. The cryophorus, *e.g.*, is spoken of first on page 29, and its derivation appears on page 53.

Of lesser blunders, we note the following:—'Réaumur' (page 16) has no accent; the equation of 180° F., 80° R, 100° C., on page 17, is risky. Of course, the context makes it clear that Dr. Wormell only means that 180 spaces, 80 spaces, 100 spaces on the three thermometric scales are equivalent; not that the mercury standing at the levels marked 180, 80, 100 respectively indicates the same temperature in the three cases. The young student might certainly be misled by the statement as it stands, and with the greater ease, seeing that on the Réaumur and Centigrade scales not only do 80 and 100 spaces correspond, but 80° R. corresponds with 100° C.

Again, the beginner who had heard of heat as a mode of motion might be confused by the heading of Lecture IV. (page 33), 'Motion of Heat: Conduction and Convection.' The word 'transference' would be certainly more safe, especially as in convection, at least, quite another motion than the molecular one of heat is concerned.

In the Ingenhous method of comparing the thermal conductivities of metal bars, by noting the different lengths of wax coating melted on them by the same source of heat, no hint is given of the important factor, specific heat, that comes into play as well as conductivity.

Three little slips in the 'Sound' lectures. The name 'tympanum' is generally used as synonymous with the middle cavity of the ear, not with the membrane only. The latter is better called '*membrana tympani*' (the membrane of the drum). The three semi-circular canals are spoken of (page 89) as 'several,' and the statement on page 92, that 'where there is no air there can be no sound,' is certainly not universally true. One can hear under water.

Let us consider the more serious mistakes. The fundamental illustration with which the book opens contains an inaccuracy that, but for its prominent position, might be classed with its lesser fellows. 'A hot plate on the scale pan of a very delicate balance' (note the 'very delicate') *would* descend as it cooled, unless it were weighed *in vacuo*. For as it cooled it would contract, and occupying less volume than before, would be buoyed up by the weight of a less volume of air than before, and would, therefore, appear to be heavier. This, not because heat has any weight, but because a cold plate is relatively heavier than a hot one, displaces less of air, is pressed upwards by a less force.

On the very next page we have a passage that seems to imply that the 'warmth' of a body is necessarily connected with the quantity of heat in it. Now, a piece of water at 0° C. is not warmer than a piece of ice at 0°. But the water has much more heat in it than the ice. Page 7 shows that this confusion in the text does not, of course, exist in the mind of the writer. A very good definition of temperature is there given. Yet, five pages later, we find Dr. Wormell talking of 'measuring temperature' instead of registering it.

On page 13 we are told that, 'by confining a liquid in some solid shell, we can constrain it to expand in only direction.' What is meant is that we can constrain it to expand *mainly* in one direction. The former feat could only be possible with a non-expanding solid envelope. On the same page, and on the twenty-second, Dr. Wormell practically contradicts himself as misrepresented in the phrase just quoted.

Again, on page 19 up turns the temperature and heat muddle. 'Only great heat can boil' mercury. Can the great heat latent in any mass of water boil mercury? A blunder in specific heat comes quite refreshingly. Dividing the rise of temperature of a mass of water by the fall of temperature of a body mixed with it will *not* give the latter's specific heat. No account is taken in the text (page 26) of the respective masses of water and 'body.'

The definition of 'energy' (page 65) is faulty. 'When a heavy body is moving it is capable of doing work before it is stopped. This working capacity is termed energy.' But when a heavy body is still (relatively to earth), it is capable, etc. A stone on the top of a tower (to use the antique illustration) has energy. Dr. Wormell means, of course, that his 'heavy body' is but an example of a body with energy. But his young readers will take it as an exhaustive case.

Our readers must not imagine from all this that there is not a great deal of good work in this volume. It is the very goodness of this work, and Dr. Wormell's real ability as a teacher, that compel us to exemplify and to protest against the blunders we have noted. The book is, despite all these, a practical, experimental one. The directions in regard to experiments, and the construction and use of apparatus given in the lectures and at the end of them, will come 'as a boon and a blessing' to many, both of the teachers and the taught.

School Hygiene, and the Diseases Incidental to School Life. By R. Farquharson, M.P., M.D., etc. Smith, Elder and Co.

One of the most hopeful features of modern education is the increasing study of the hygienic conditions under which it is carried on, as shown by the issue of numerous manuals on school hygiene. The largest and most ambitious book we have yet seen on the subject is the one before us, and the libraries of the head-master and medical attendant of our large public schools cannot be considered complete without it.

Dr. Farquharson has discussed in a most pleasant and readable manner, the chief problems of health at school, considering in turn school buildings, diet, work, play, and diseases. It is unfortunate that apart from the bare headings of the chapters, which by no means furnish a complete or even correct view of their contents, no guide is given which would enable one to refer to any point of importance. The total absence of an index, and the uniformity of type throughout the book, render the search for the different subjects a most difficult matter. It may be hoped that in a future edition this and a few errors, evidently due to hasty composition, will be rectified.

The discussion of the subject of ventilation and warming

is unsatisfactory. No system of ventilation of a large schoolroom which depends on Tobin's tubes for ingress and open fire-places for egress of air, will be able to supply the 3,000 cubic feet of air per scholar, which Dr. Farquharson declares desirable. We think, too, that it is not heated air *per se* which is objectionable in American systems, but it is the direct radiation from hot steam or water-pipes, which is declared by American sanitarians to be 'the most killing system in existence.' When the incoming air is warmed by passing over coils of hot pipes; while at the same time, by means of other hot pipes, impure air is exhausted from the room, we have a system which has been most successful in America, and which would be the best system in winter for this country. It is not warmed air which is objectionable, but the impurities so commonly associated with it.

On p. 40 starch and sugar are described as hydro-carbons instead of carbo-hydrates. The conversion of these into fat, which is stated by Dr. Farquharson to occur, is contradicted by the best modern results. The true explanation is probably that they serve as an easily combustible material which allows the accumulation of fat in the system.

We are at a loss how to reconcile the statement on p. 47, that 'up to the time of the first dentition nothing but milk should be allowed, any form of starchy food merely acting as a foreign body'; with the statement on the same page that 'about the fifth month' (*i.e.*, at least two months before dentition commences) 'a little animal food is not out of place, ranging from a little gravy mixed with potatoes, up to meat finely divided by chopping.'

Supper at our public schools is recommended to be composed of bread and cheese and *beer*, as an alternative for porridge and milk. The beer we consider as quite unjustifiable for boys, except under direct medical direction. In cases known to the writer, scandal has resulted from this plan, several boys' shares having been consumed by a specially thirsty member of the supper table.

The question of overwork in Board and other schools is very ably discussed, the arguments on both sides being most fairly stated, and the conclusion being arrived at, that in most cases over-pressure means underfeeding.

The last one hundred and fifty pages of the book are occupied with a discussion of the duties of the school doctor, and the recognition and treatment of school diseases. The remarks of the author evidently apply chiefly to large public schools like Rugby, and the detailed discussion of questions of quarantine, and the management of children's complaints is rather superfluous for the elementary school teacher, though very useful for the masters and medical attendants of boarding schools.

We are greatly surprised to find Dr. Farquharson doubting the existence of Röthelu or German measles as a separate disease from ordinary measles. Doubtless, differentiation of the two is sometimes difficult, but there can be no more doubt of their separate existence, than of the distinctness of typhus and typhoid fevers.

The pages devoted to the discussion of eyesight in schools, spinal curvature from bad posture, and gymnastics for girls are well worthy of study, having been written by specialists.

We are glad to see that Dr. Farquharson urges the appointment of the medical officer of health of each district, as the medical officer of its various schools, to advise as to ventilation, warming, prevention of infectious diseases, etc. Such a plan would be productive of great good, and would doubtless nip in the bud many outbreaks of epidemic diseases which now, through the means of communication afforded by school-life, cut off thousands of lives.

Object Lessons, and How to Give Them.

By G. Ricks, B.Sc. W. Isbister (Limited).

The author tells us that the purpose of these lessons is to develop the faculties of the mind, to quicken the intelligence, to train to habits of accurate observation, exact comparison, and sound reasoning, and to excite an interest in all those objects with which we daily come in contact, and those natural phenomena which constantly appear before our eyes. In the first stage, attention is drawn to the common properties of solids; in the second stage liquids and gases are similarly dealt with; while in the third, fourth, and fifth stages some of the simplest laws of nature are explained in the simplest way.

This is no doubt an honest and successful attempt to fix the child's attention on the world around him. Articles for illustration are pointed out; experiments are described, and methods indicated. Young teachers will be saved much trouble, and at the same time be enabled to give sound instruction by following the directions in this book. It is clearly printed, well illustrated, and excellently arranged. One must not underrate the difficulty of explaining simple laws in simple language. Some slips must be expected. It seems, however, a pity that these pages were not submitted to a competent critic before passing through the press. Some unguarded expressions would have been struck out. We will take an instance of what we mean from the lesson on the thermometer. We are supposed to put one hand in cold water, and the other in warm water, and then to put both hands in a mixture of the warm and cold. To the hand that had been in the cold water, this mixture will appear warm, and to the other cold. This is instructive enough. The author goes on to say, 'This shows us that our sense of feeling is not a correct measure of heat.' A little farther on, in answer to the question how we measure heat, we are told that the amount of expansion which bodies undergo under varying temperatures is the best measure of heat. Such blunders are very serious indeed. To teach a boy that a thermometer is an instrument to measure heat with, is to teach him what he must unlearn before he can understand anything worth knowing about the subject. To be able to write simply and accurately is a rare accomplishment, but it is indispensable if the simplest laws are to be explained in the simplest possible way.

Notes on School Management.

By G. Collins. Moffatt and Paige, Warwick Lane, Paternoster Row.

This concise manual of 176 pages was written, the author tells us, with special reference to the Code of 1882, and the Circulars of Instruction relating thereto. Part I., which is devoted to organisation, deals with school premises, furniture and apparatus, classification, school staff, time-tables, and registration. Part II. is head-training; its general principles, physical education, training the intellect, moral training, rewards and punishments. Part III. treats of instruction, under the heads of oral teaching, reading, writing, spelling, arithmetic, and class subjects.

This book is the outcome of much practical experience and accurate knowledge. The distinguishing feature of it is clearness. Mr. Collins knows what he wants to say, and he says it well, not so that people can understand him if they try, but so that they cannot misunderstand him if they try. One can no more learn to teach than he could learn to swim by merely reading a book, or attending a course of lectures. But practice without instruction is as wasteful as instruction without practice is inefficient. We need both.

Mr. Collins' notes cannot fail to be of great assistance to the young teacher who studies it carefully. We wish it all the success it deserves. It cannot be expected that so extensive a subject as school management can be adequately dealt with in a small manual. The foundations of the art of teaching lie in the laws of mental development, and these cannot be set out in a few pages. Those who wish to know the reasons for the methods they employ must go beyond the limits of the manual before us, and acquire at least the elements of psychology and logic. Elementary teachers owe a debt of gratitude to the Rev. T. W. Sharpe for making this a part of the curriculum of every student in training. A knowledge of

the laws of mental growth, and the principles of exposition and proof will enable our teachers to work with more ease and efficiency. When will this be recognised in regard to the high schools? Does the theory of education only apply to Board schools? Is it not time that the universities should do for the grammar schools what the Government has done for the nation at large? For years past nearly the only trained teachers have been those destined for elementary schools.

A Manual of Health Science. By Dr. Andrew Wilson. Longman, Green and Co.

The South Kensington examinations, the editing of a popular scientific journal, 'Health,' and, without doubt, a desire to do good, have actuated the writer in bringing out this book. That the former is the case is owned on the title page and preface directly, and, indirectly, by a series of questions at the end. That the editing of 'Health,' with its inartistic, unscientific, and therefore ugly interleaf advertisements has had something to do with the bringing out of the volume under consideration is evident, in that certain parts of it have appeared, or are even now appearing in the journal. But higher motives may have influenced Dr. Wilson, who clearly feels strongly on the subject with which he deals, and, what is more, knows it very well.

The little work, though of design popular in style, is on the whole refreshingly accurate. There are one or two actual blunders, and one or two errors of judgment. *E.g.*, gastric juice does not contain 99 per cent. of solid matter, and secreted is not equivalent to manufactured. Of errors in judgment that detract from the value of the book as a whole, we note the absence of derivations, the use of English weights and measures, without even the giving of their metrical equivalents, the misnomenclature whenever chemical terms are used (our old enemies chloride of magnesia, and salts of potash, turn up again), and the use of the Fahrenheit thermometric scale without a reference to the Centigrade. We must also enter our protest very seriously against the persistent advertising that goes on throughout the whole of the book. Probably there is some difficulty in describing methods of ventilation or healthy soaps without a wild compelling to proclaim the places where and the people from whom they may be had. But Dr. Wilson certainly carries the thing too far, and though doubtless he is above suspicion, yet equally without doubt many reading his book will ask if he does not receive an equivalent in kind from the firms he advertises.

Perhaps the best fact about the manual is the excellently practical nature of it. Really good work is done when people are taught how, in a simple way, they can best purify the foulness of the air in their rooms and can see if the drains of a potential home for them are in good order. Most admirable again is the chapter on 'Local Conditions of Health.'

On the three V's Dr. Wilson has much to say. Ventilation is a strong point with him, and but for the recurrence of names and addresses which makes the sixth chapter read rather like a directory, everything here would be most welcome. On vaccination and vegetarianism he speaks out with no uncertain sound, declaring roundly for the former and against the latter, if it is to be the sole method of feeding 'the human form divine.'

Dr. Wilson writes with feeling about the unhappy conditions of our working classes, though he does not point out that these unhappy conditions are not, as a rule, due to any fault of the workers, but to the unhealthy state of the society of which they are a part. He speaks of the various diseases to which the particular workers are subject—'wool-sorter's disease,' 'mason's lung,' and so forth. But he does not protest against that morally unhealthy greed which reckons the health and even the lives of the working population as of secondary moment when compared with the acquisition of wealth.

There is nothing to show, we may note in finishing, that Fig. 8, p. 21, is a view of the stomach, etc., not in their normal positions, but turned up and back. This omission would tend to mislead a learner.

Magnetic and Electrical Laws, with Notes. By E. Hurren Harding. W. Collins and Sons.

This is a small book of 32 pages, not intended as a substitute for existing text-books, but as a collection and condensation of useful truths, or as notes which may serve for the foundation of lessons.

Many students are not apt at taking notes. Teachers often dictate such statements as they fear would be incorrectly stated. This takes time. A printed summary is, no doubt, very convenient. There is, however, something arbitrary about the selection of such notes. One teacher may not find another's quite to his mind. Of the 239 statements here set down, we should be inclined to cut out a great many, and, of course, to add others. We are told, for instance, that Watts = amperes × volts, and that a horse-power = 746 Watts. It is not stated what a horse-power is. The book may be found useful. We cannot strongly recommend it.

Key to the Elements of Euclid. By J. S. Mackay. W. and R. Chambers.

This is a key to the excellent edition of Euclid's Elements lately published by Messrs. Chambers. That edition was so well received by all competent authorities that we need do no more than recall its name to those who are looking out for one of the best works on the subject in the English language. The author has now published the solutions to the deductions. In doing so he followed very good precedents. The work before us is distinguished by the amount and excellence of the matter it contains. Answers are given to the questions specially relating to the successive propositions of Euclid's text as well as to the deductions at the end of the books. When we remember how fully the author treated the subject, the wonder is that such an admirable key could have been comprised within 300 pages. Space has been saved as the preface informs us by omitting all such figures as appear in the original volume, or can be drawn by following the directions given. A valuable hint from De Morgan has been acted upon. De Morgan says: 'I am satisfied from sufficient trial, that when proper description of the diagram is given in the text, the person who draws his own diagram from the text, will arrive at the author's meaning in half the time which is employed by another, to whom the successive appearances of the parts is prevented by his seeing the whole from the beginning.' This remark applies to the mastery of a new proposition of Euclid as much as to a deduction.

We may add in conclusion, though it may be to many quite superfluous, that the book is well printed on good paper, and that the binding is worthy of the book, and maintains the publishers' character for cheapness and excellence.

The School-Manager's Manual. F. C. Mills, M.A. Cassell and Company.

This is a most useful shilling manual. It is primarily intended for managers of London Board Schools. Indeed it is particularly adapted for them, embodying as it does the more important of the London Board regulations with those of the Code. But it may be used with advantage by any one who has taken enough interest in educational work to become a school-manager. School-managers are supposed and expected to do many things which require care, knowledge, and experience. Frequent visits to the school, quiet observation of how matters proceed in the regular course is the surest way for a manager to learn to be serviceable.

Too much interference, however, does no good. Schools may be over-managed as well as under-managed. The first great duty of the managers is to select a competent and trustworthy man for the head teacher, and then let him alone. Whoever heard of the governors of, say, Dulwich College, 'doing their utmost to promote harmony and good-will between parents and

teachers'? And surely it is not often necessary for a teacher to call in the aid of his managers to secure the good-will of the parents. A good teacher has that, and the love of the children too. We make these remarks because there is an evident desire in some places to lay too much stress on the management of schools. Where such a course ends in the curtailment of the liberty, independence, and individuality of the teachers, it is an unmixed evil. Too many regulations will in the end be found worse than too few. We wish the manual before us all success. It is clear, concise, and accurate.

The Scholar's History of England. By J. S. Horn. Manchester: J. Heywood.

In a hundred lessons of about a page and a-half each, the author has dealt with the main facts of English History from the earliest times to the year 1885. Facts are clearly and simply stated in short paragraphs. The book is no doubt intended to be used as a reading book, the teacher explaining as the lesson goes on; or it can be used as a sort of epitome and permanent record of the instruction in English History received in the school. History as a subject of instruction in elementary schools is somewhat out of fashion at the present time. There is no doubt that it requires skilful teaching. It also requires skilful examining before it is set aside as unfit for common school purposes. Perhaps the inspectors, not less than the teachers, need to consider what is essential—how it should be taught, and what sort of evidence of having learned it the children should be expected to give. Opinions may differ widely as to whether there is time to teach history at all, when so many other subjects of higher value for discipline and instruction are crowded out. But while history continues to be one of the subjects recognised by the code we may rest assured that it will be taught, and so long there will be room for books like the one before us, which very fairly meets the requirements of the case, and is both good and cheap.

The Wanderings of Ulysses. By Professor C. Witt. Translated by Frances Younghusband. London: Longmans, Green, and Co.

Professor Witt, headmaster of the Altstadt Gymnasium, Königsberg, has done into German the Myths of Hellas, the Trojan War, and the Odusseus' Wanderings. Frances Younghusband has done these again into English. The man's work has, of course, been paraphrasing; that of the woman, translation. We have not seen the originals of any of these three works, nor the translations of the first and second. But our glance at the English rendering of the third, and our reading of a considerable portion of it, enables us to say that, as far as we have seen, the work of translator and translatee has been well done.

It is, of course, a question still open, whether it is wiser to give young people a literal translation or only a paraphrase of the old Greek stories. But if we waive this inquiry, or answer it in favour of the paraphrase, it is certainly difficult to imagine anything better of its kind than the volume before us. The fine old stories are told with almost a Greek simplicity, and with not a little of genuine poesy. How fine they are we need not pause to say. If only our children are brought up on these or on the Northern tales of Sigurd and Hotli, and their stupendous fellows (are they not written in the literal translation of William Morris and Manguissen, and in the poem paraphrases of the former?), or on Grimm, they will be the happier, the braver, and the purer.

The pronunciation of the classical names in this work is denoted in the index, not in the body of the book. The wisdom of this arrangement seems doubtful. Oddly enough, and, doubtless, quite exceptionally, the first one we took as a test hardly meets the requirements. 'PosEIdon,' with no mark — or ⌣ over the last 'o,' tells nothing of the length of that letter to the beginner.

[*Several Reviews are unavoidably crowded out.*]

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